LE910 Hardware User Guide

1vv03701089 Rev.4 – 10-10-2014

Making machines talk.

Applicability Table

PRODUCT
LE910-EUG
LE910-NAG
LE910-NVG
LE910-SVG
LE910-SKG

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1 Introduction

1.1 Scope

The aim of this document is the description of some hardware solutions useful for developing a product with the Telit LE910 module.

1.2 Audience

This document is intended for Telit customers, who are integrators, about to implement their applications using our LE910 modules.

1.3 Contact Information, Support

For general contact, technical support, to report documentation errors and to order manuals, contact Telit's Technical Support Center (TTSC) at:

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Alternatively, use:
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For detailed information about where you can buy the Telit modules or for recommendations on accessories and components visit:
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1.4 Text Conventions

Danger – This information MUST be followed or catastrophic equipment failure or bodily injury may occur.

Caution or Warning – Alerts the user to important points about integrating the module, if these points are not followed, the module and end user equipment may fail or malfunction.

Tip or Information – Provides advice and suggestions that may be useful when integrating the module.

All dates are in ISO 8601 format, i.e. YYYY-MM-DD.

1.5 Related Documents

• LE910 Product description	80421ST10587a
• SIM Holder Design Guides	80000NT10001a
• AT Commands Reference Guide	80421ST10585A
• LE910 DVI Application Note	80000NT11246A
• Telit EVK2 User Guide	1vv0300704

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1.6 Document History

Revision	Date	Changes
ISSUE#0	2013-11-07	Preliminary Version
ISSUE#1	2013-12-20	Updated schematics & tray drawing;
ISSUE#2	2014-05-12	Added LE910-SVG and LE910-SKG; LE910-EUG now Dual Band 2G (900/1800); added B5 WCDMA on LE910-EUG.
ISSUE#3	2014-06-19	Added Conformity assessment issues section for LE910-NVG, SVG and NAG; updated chapter 10 (USB).
ISSUE#4	2014-10-10	Updated Power Consumption values; Updated STAT_LED status table Updated Pad layout Removed section 1.4 (Document Organization) Added Sensitivity values Updated Chapters 3.1, 6.4, 6.5, 6.6, 6.7, 7.2, 7.2.1, 7.2.3, 10.1 Updated GNSS specification

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2 Overview

The aim of this document is the description of some hardware solutions useful for developing a product with the Telit LE910 module.
In this document all the basic functions of a mobile phone will be taken into account; for each one of them a proper hardware solution will be suggested and eventually the wrong solutions and common errors to be avoided will be evidenced. Obviously this document cannot embrace the whole hardware solutions and products that may be designed. The wrong solutions to be avoided shall be considered as mandatory, while the suggested hardware configurations shall not be considered mandatory, instead the information given shall be used as a guide and a starting point for properly developing your product with the Telit LE910 module. For further hardware details that may not be explained in this document refer to the Telit LE910 Product Description document where all the hardware information is reported.

NOTICE:
(EN) The integration of the GSM/GPRS/WCDMA/LTE **LE910** cellular module within user application shall be done according to the design rules described in this manual.

(IT) L'integrazione del modulo cellulare GSM/GPRS/WCDMA/LTE **LE910** all'interno dell'applicazione dell'utente dovrà rispettare le indicazioni progettuali descritte in questo manuale.

(DE) Die Integration des **LE910** GSM/GPRS/WCDMA/LTE Mobilfunk-Moduls in ein Gerät muß gemäß der in diesem Dokument beschriebenen Kunstruktionsregeln erfolgen.

(SL) Integracija GSM/GPRS/WCDMA/LTE **LE910** modula v uporabniški aplikaciji bo morala upoštevati projektna navodila, opisana v tem priročniku.

(SP) La utilización del modulo GSM/GPRS/WCDMA/LTE **LE910** debe ser conforme a los usos para los cuales ha sido deseñado descritos en este manual del usuario.

(FR) L'intégration du module cellulaire GSM/GPRS/WCDMA/LTE **LE910** dans l'application de l'utilisateur sera faite selon les règles de conception décrites dans ce manuel.

(HE) האינטגרטור מתבקש ליישם את ההנחיות המפורטות במסמך זה בתהליך האינטגרציה של המודם הסלולרי **LE910** עם המוצר.

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3 LE910 module connections

3.1 PIN-OUT

PAD	Signal	I/O	Function	Type	COMMENT
USB HS 2.0 COMMUNICATION PORT					
B15	USB_D+	I/O	USB differential Data (+)		
C15	USB_D-	I/O	USB differential Data (-)		
A13	VUSB	I	Power sense for the internal USB transceiver.		
Asynchronous Serial Port (USIF0) – Prog. / Data + HW Flow Control					
N15	C103/TXD	I	Serial data input from DTE	CMOS 1.8V	
M15	C104/RXD	O	Serial data output to DTE	CMOS 1.8V	
M14	C108/DTR	I	Input for (DTR) from DTE	CMOS 1.8V	
L14	C105/RTS	I	Input for Request to send signal (RTS) from DTE	CMOS 1.8V	
P15	C106/CTS	O	Output for Clear to Send signal (CTS) to DTE	CMOS 1.8V	
N14	C109/DCD	O	Output for (DCD) to DTE	CMOS 1.8V	
P14	C107/DSR	O	Output for (DSR) to DTE	CMOS 1.8V	
R14	C125/RING	O	Output for Ring (RI) to DTE	CMOS 1.8V	
Asynchronous Auxiliary Serial Port (USIF1)					
D15	TX_AUX	O	Auxiliary UART (TX Data to DTE)	CMOS 1.8V	
E15	RX_AUX	I	Auxiliary UART (RX Data from DTE)	CMOS 1.8V	
SIM card interface					
A6	SIMCLK	O	External SIM signal – Clock	1.8 / 3V	
A7	SIMRST	O	External SIM signal – Reset	1.8 / 3V	
A5	SIMIO	I/O	External SIM signal – Data I/O	1.8 / 3V	
A4	SIMIN	I	External SIM signal – Presence (active low)	CMOS 1.8	
A3	SIMVCC	-	External SIM signal – Power supply for the SIM	1.8 / 3V	
Digital Voice Interface (DVI)					
B9	DVI_WA0	I/O	Digital Audio Interface (WA0)	1.8V	
B6	DVI_RX	I	Digital Audio Interface (RX)	1.8V	
B7	DVI_TX	I/O	Digital Audio Interface (TX)	1.8V	
B8	DVI_CLK	I/O	Digital Audio Interface (CLK)	1.8V	
DIGITAL IO					
C8	GPIO_01	I/O	GPIO_01 /STAT LED	CMOS 1.8V	Alternate Function STAT LED
C9	GPIO_02	I/O	GPIO_02	CMOS 1.8V	
C10	GPIO_03	I/O	GPIO_03	CMOS 1.8V	
C11	GPIO_04	I/O	GPIO_04	CMOS 1.8V	

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B14	GPIO_05	I/O	GPIO_05	CMOS 1.8V	
C12	GPIO_06	I/O	GPIO_06	CMOS 1.8V	
C13	GPIO_07	I/O	GPIO_07	CMOS 1.8V	
K15	GPIO_08	I/O	GPIO_08	CMOS 1.8V	
L15	GPIO_09	I/O	GPIO_09	CMOS 1.8V	
G15	GPIO_10	I/O	GPIO_10	CMOS 1.8V	
ADC					
B1	ADC_IN1	AI	Analog / Digital converter input	A/D	
RF SECTION					
K1	ANTENNA	I/O	GSM/EDGE/UMTS Antenna (50 ohm)	RF	
F1	ANT_DIV	I	Antenna Diversity Input (50 ohm)	RF	
GNSS SECTION (see NOTE1)					
R9	ANT_GNSS	I	GNSS Antenna (50 ohm)	RF	
R7	GNSS_LNA_EN	O	Output enable for External LNA supply	CMOS 1.8V	
Miscellaneous Functions					
R13	HW_SHUTDOWN*	I	HW Unconditional Shutdown	1.8V	Active low
R12	ON_OFF*	I	Input command for power ON	1.8V	Active low
C14	VRTC	I	VRTC Backup capacitor	Power	backup for the embedded RTC supply
R11	VAUX/PWRMON	O	Supply Output for external accessories / Power ON Monitor	1.8V	
Power Supply					
M1	VBATT	-	Main power supply (Baseband)	Power	
M2	VBATT	-	Main power supply (Baseband)	Power	
N1	VBATT_PA	-	Main power supply (Radio PA)	Power	
N2	VBATT_PA	-	Main power supply (Radio PA)	Power	
P1	VBATT_PA	-	Main power supply (Radio PA)	Power	
P2	VBATT_PA	-	Main power supply (Radio PA)	Power	
E1	GND	-	Ground	Power	
G1	GND	-	Ground	Power	
H1	GND	-	Ground	Power	
J1	GND	-	Ground	Power	
L1	GND	-	Ground	Power	
A2	GND	-	Ground	Power	
E2	GND	-	Ground	Power	
F2	GND	-	Ground	Power	
G2	GND	-	Ground	Power	
H2	GND	-	Ground	Power	
J2	GND	-	Ground	Power	
K2	GND	-	Ground	Power	
L2	GND	-	Ground	Power	
R2	GND	-	Ground	Power	

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M3	GND	-	Ground	Power	
N3	GND	-	Ground	Power	
P3	GND	-	Ground	Power	
R3	GND	-	Ground	Power	
D4	GND	-	Ground	Power	
M4	GND	-	Ground	Power	
N4	GND	-	Ground	Power	
P4	GND	-	Ground	Power	
R4	GND	-	Ground	Power	
N5	GND	-	Ground	Power	
P5	GND	-	Ground	Power	
R5	GND	-	Ground	Power	
N6	GND	-	Ground	Power	
P6	GND	-	Ground	Power	
R6	GND	-	Ground	Power	
P8	GND	-	Ground	Power	
R8	GND	-	Ground	Power	
P9	GND	-	Ground	Power	
P10	GND	-	Ground	Power	
R10	GND	-	Ground	Power	
M12	GND	-	Ground	Power	
B13	GND	-	Ground	Power	
P13	GND	-	Ground	Power	
E14	GND	-	Ground	Power	
RESERVED					
C1	RESERVED	-	RESERVED		
D1	RESERVED	-	RESERVED		
B2	RESERVED	-	RESERVED		
C2	RESERVED	-	RESERVED		
D2	RESERVED	-	RESERVED		
B3	RESERVED	-	RESERVED		
C3	RESERVED	-	RESERVED		
D3	RESERVED	-	RESERVED		
E3	RESERVED	-	RESERVED		
F3	RESERVED	-	RESERVED		
G3	RESERVED	-	RESERVED		
H3	RESERVED	-	RESERVED		
J3	RESERVED	-	RESERVED		
K3	RESERVED	-	RESERVED		
L3	RESERVED	-	RESERVED		
B4	RESERVED	-	RESERVED		
C4	RESERVED	-	RESERVED		

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B5	RESERVED	-	RESERVED		
C5	RESERVED	-	RESERVED		
C6	RESERVED	-	RESERVED		
C7	RESERVED	-	RESERVED		
N7	RESERVED	-	RESERVED		
P7	RESERVED	-	RESERVED		
N8	RESERVED	-	RESERVED		
N9	RESERVED	-	RESERVED		
A10	RESERVED	-	RESERVED		
N10	RESERVED	-	RESERVED		
N11	RESERVED	-	RESERVED		
P11	RESERVED	-	RESERVED		
B12	RESERVED	-	RESERVED		
D12	RESERVED	-	RESERVED		
N12	RESERVED	-	RESERVED		
P12	RESERVED	-	RESERVED		
F14	RESERVED	-	RESERVED		
G14	RESERVED	-	RESERVED		
H14	RESERVED	-	RESERVED		
J14	RESERVED	-	RESERVED		
K14	RESERVED	-	RESERVED		
N13	RESERVED	-	RESERVED		
L13	RESERVED	-	RESERVED		
J13	RESERVED	-	RESERVED		
M13	RESERVED	-	RESERVED		
K13	RESERVED	-	RESERVED		
H13	RESERVED	-	RESERVED		
G13	RESERVED	-	RESERVED		
F13	RESERVED	-	RESERVED		
A11	RESERVED	-	RESERVED		
A12	RESERVED	-	RESERVED		
B11	RESERVED	-	RESERVED		
B10	RESERVED	-	RESERVED		
A9	RESERVED	-	RESERVED		
A8	RESERVED	-	RESERVED		
D14	RESERVED	-	RESERVED		
A14	RESERVED	-	RESERVED		
D13	RESERVED	-	RESERVED		
E13	RESERVED	-	RESERVED		
F15	RESERVED	-	RESERVED		
H15	RESERVED	-	RESERVED		
J15	RESERVED	-	RESERVED		

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WARNING:

Reserved pins must not be connected.

NOTE:

If not used, almost all pins should be left disconnected. The only exceptions are the following pins:

PAD	Signal	Notes
M1,M2,N1,N2,P1,P2	VBATT & VBATT_PA	
E1,G1,H1,J1,L1,A2,E2,F2,G2,H2, J2,K2,L2,R2,M3,N3,P3,R3,D4,M4, N4,P4,R4,N5,P5,R5,N6,P6,R6,P8, R8,P9,P10,R10,M12,B13,P13,E14	GND	
R12	ON/OFF*	
R13	HW_SHUTDOWN*	
B15	USB_D+	If not used should be connected to a Test Point or an USB connector
C15	USB_D-	If not used should be connected to a Test Point or an USB connector
A13	VUSB	If not used should be connected to a Test Point or an USB connector
N15	C103/TXD	If not used should be connected to a Test Point
M15	C104/RXD	If not used should be connected to a Test Point
D15	TXD_AUX	If not used should be connected to a Test Point
E15	RXD_AUX	If not used should be connected to a Test Point
K1	MAIN ANTENNA	
F1	ANT_DIV	
R9	ANT_GNSS	If the GNSS is not used it could be left unconnected

RTS pin should be connected to the GND (on the module side) if flow control is not used.

The above pins are also necessary to debug the application when the module is assembled on it so we recommend connecting them also to dedicated test point.

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3.1.1 LGA Pads Layout

TOP VIEW

	A	B	C	D	E	F	G	H	J	K	L	M	N	P	R
1		ADC_IN1	RES	RES	GND	ANT_DIV	GND	GND	GND	ANT	GND	VBATT	VBATT_PA	VBATT_PA	
2	GND	RES	RES	RES	GND	GND	GND	GND	GND	GND	GND	VBATT	VBATT_PA	VBATT_PA	GND
3	SIMVCC	RES	RES	RES	RES	RES	RES	RES	RES	RES	RES	GND	GND	GND	GND
4	SIMIN	RES	RES	GND								GND	GND	GND	GND
5	SIMIO	RES	RES										GND	GND	GND
6	SIMCLK	DVI_RX	RES										GND	GND	GND
7	SIMRST	DVI_TX	RES										RES	RES	GNSS_LNA_EN
8	RES	DVI_CLK	GPIO_01										RES	GND	GND
9	RES	DVI_WA0	GPIO_02										RES	GND	ANT_GNSS
10	RES	RES	GPIO_03										RES	GND	GND
11	RES	RES	GPIO_04										RES	RES	VAUX/PWRMON
12	RES	RES	GPIO_06	RES								GND	RES	RES	ON_OFF*
13	VUSB	GND	GPIO_07	RES	RES	RES	RES	RES	RES	RES	RES	RES	RES	GND	HW_SHUTDOWN*
14	RES	GPIO_05	VRTC	RES	GND	RES	RES	RES	RES	RES	C105/RTS	C108/DTR	C109/DCD	C107/DSR	C125/RING
15		USB_D+	USB_D-	TX AUX	RX AUX	RES	GPIO_10	RES	RES	GPIO_08	GPIO_09	C104/RXD	C103/TXD	C106/CTS	

NOTE:

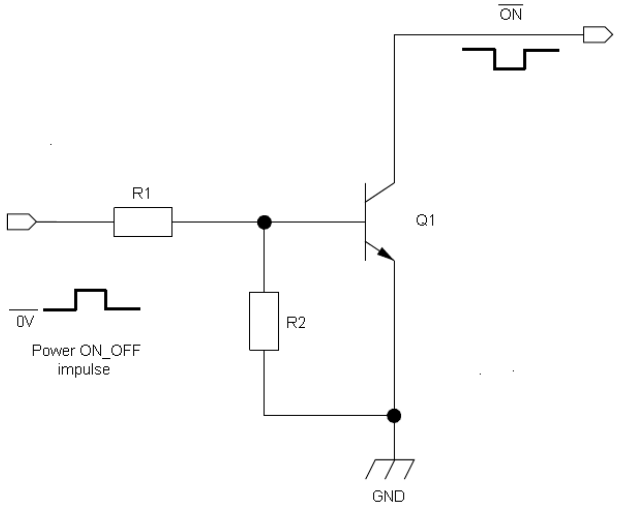
The pin defined as RES has to be considered RESERVED and not connected on any pin in the application.

4 Hardware Commands

4.1 Turning ON the LE910

To turn on the LE910 the pad ON_OFF* must be tied low following timing diagram in Chapter 4.2.

The maximum current that can be drained from the ON_OFF* pad is 0,1 mA.
A simple circuit for this purpose is:



NOTE:

Don't use any pull up resistor on the ON_OFF* line, it is internally pulled up. Using pull up resistor may bring to latch up problems on the LE910 power regulator and improper power on/off of the module. The line ON_OFF* must be connected only in open collector or open drain configuration.

NOTE:

In this document all the lines that are inverted, hence have active low signals are labelled with a name that ends with"#","*" or with a bar over the name.

TIP:

VAUX/PWRMON pad can be monitored to check if LE910 has powered on.

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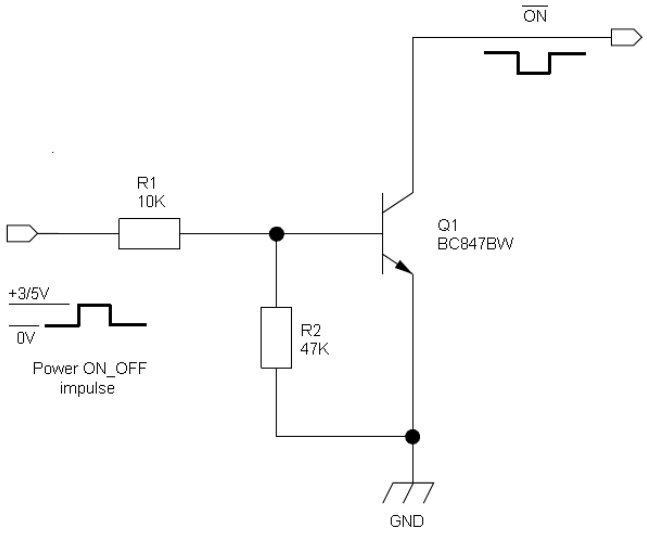
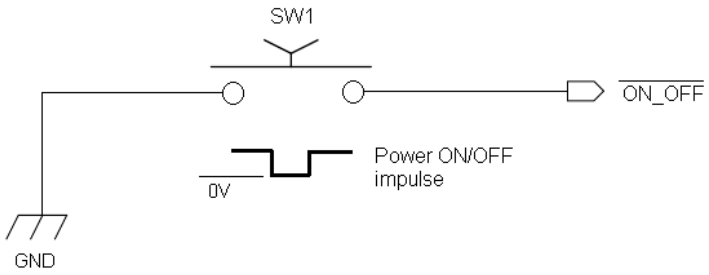
For example:

1- Let's assume you need to drive the ON_OFF* pad with a totem pole output of a +3/5 V microcontroller (uP_OUT1):



2- Let's assume you need to drive the ON_OFF* pad directly with an ON/OFF button:



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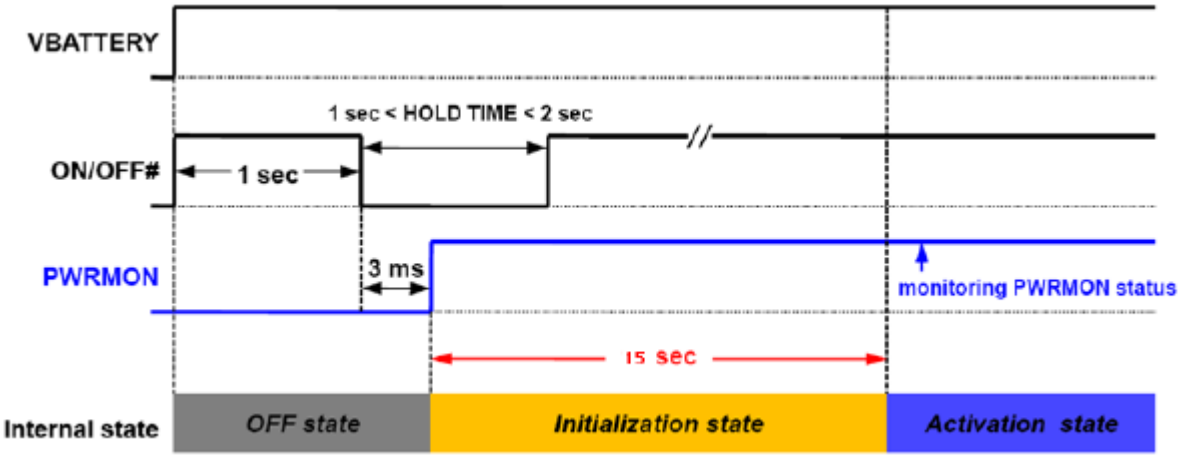
4.2 Initialization and Activation state

The LE910 takes about 15 seconds to complete internal initialization and to be ready for normal operation.



NOTE:

Any kind of AT-command is not available during the *Initialization state.*

DTE can send AT-commands only in *Activation state*

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4.3 Turning OFF the LE910

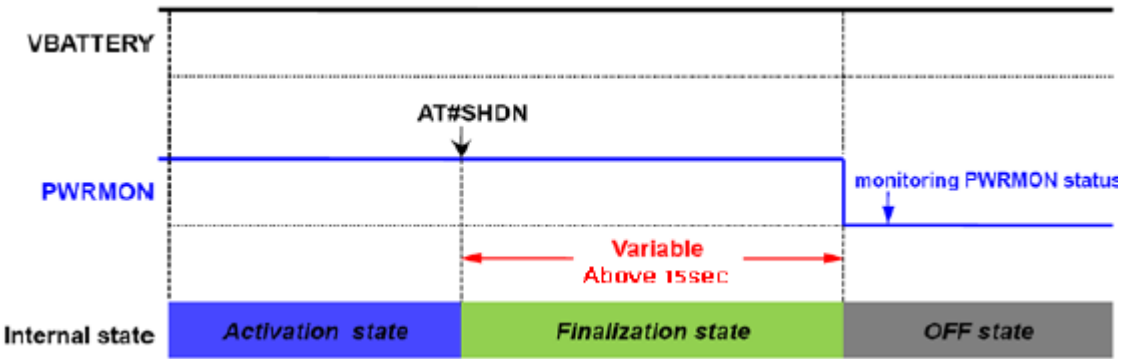
Turning off of the device can be done in two ways:

- via AT command (see LE910 Software User Guide, AT#SHDN)
- by tying low pin ON_OFF* for 2 second

Either ways, the LE910 issues a detach request to network and saves all parameters in the internal memory and in the simcard.

4.3.1 Shutdown by Software Command

LE910 can be shut down using the AT#SHDN command.
When a shutdown command is sent, LE910 goes into the finalization state and finally will shut down PWRMON at the end of this state.
The period of the finalization state can differ according to the situation in which the LE910 is so it cannot be fixed definitely.
Normally it will be above 15 seconds later from sending a shutdown command and DTE should monitor the status of PWRMON to see the actual power off.



TIP:

To check if the device has been powered off, the hardware line PWRMON must be monitored. The device is powered off when PWRMON goes low.

NOTE:

In order to avoid a back powering effect it is recommended to avoid having any HIGH logic level signal applied to the digital pins of the LE910 when the module is powered off or during an ON/OFF transition.

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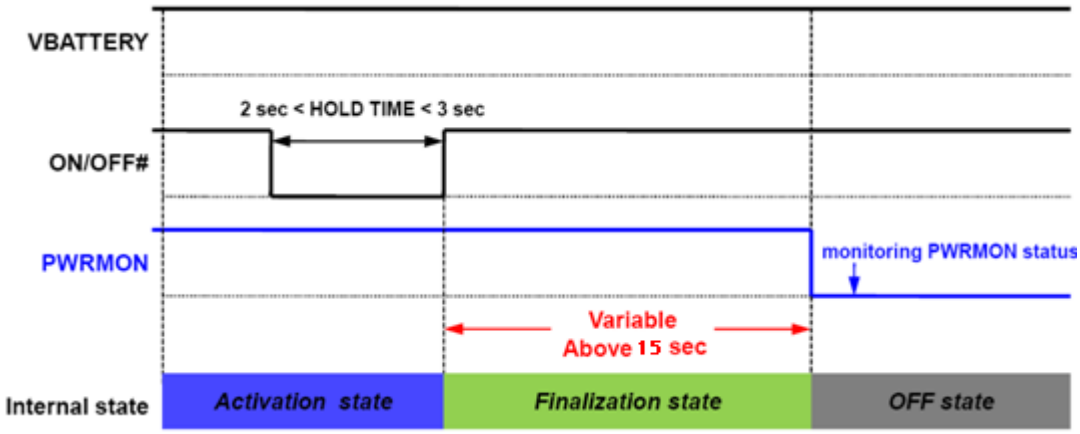
4.3.2 Hardware Shutdown

To turn OFF LE910 the pad ON/OFF# must be tied low for at least 2 seconds and then released. Same circuitry and timing for the power on must be used.
When the hold time of ON/OFF# is above 2 seconds, LE910 goes into the finalization state and finally will shut down PWRMON at the end of this state.
The period of the finalization state can differ according to the situation in which the LE910 is so it cannot be fixed definitely.
Normally it will be above 15 seconds later from releasing ON/OFF# and DTE should monitor the status of PWRMON to see the actual power off.



TIP:

To check if the device has been powered off, the hardware line PWRMON must be monitored. The device is powered off when PWRMON goes low.

NOTE:

In order to avoid a back powering effect it is recommended to avoid having any HIGH logic level signal applied to the digital pins of the LE910 when the module is powered off or during an ON/OFF transition.

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4.4 LE910 Unconditional Shutdown

The Unconditional Shutdown of the module could be activated using the HW_SHUTDOWN* line (pad R13).

WARNING:

The hardware unconditional Shutdown must not be used during normal operation of the device since it does not detach the device from the network. It shall be kept as an emergency exit procedure.

To unconditionally shutdown the LE910, the pad HW_SHUTDOWN* must be tied low for at least 200 milliseconds and then released.

NOTE:

Do not use any pull up resistor on the HW_SHUTDOWN* line nor any totem pole digital output. Using pull up resistor may bring to latch up problems on the LE910 power regulator and improper functioning of the module. The line HW_SHUTDOWN* must be connected only in open collector configuration.

The HW_SHUTDOWN* is generating an unconditional shutdown of the module without an automatic restart.

The module will shutdown, but will NOT perform the detach from the cellular network.

To proper power on again the module please refer to the related paragraph (“Powering ON the HE910”)

TIP:

The unconditional hardware shutdown must always be implemented on the boards and should be used only as an emergency exit procedure.

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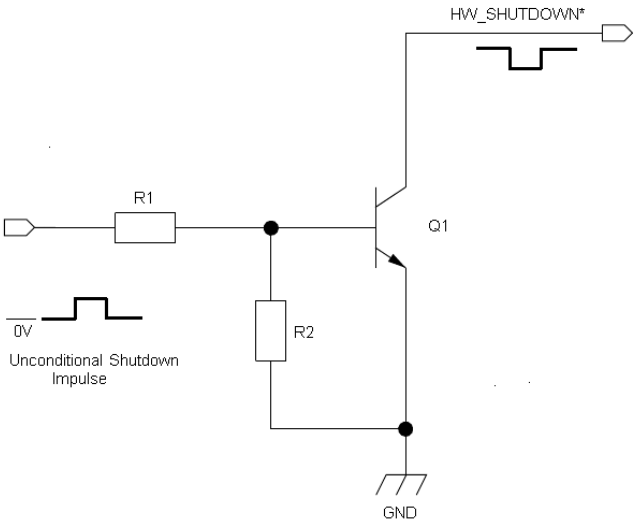
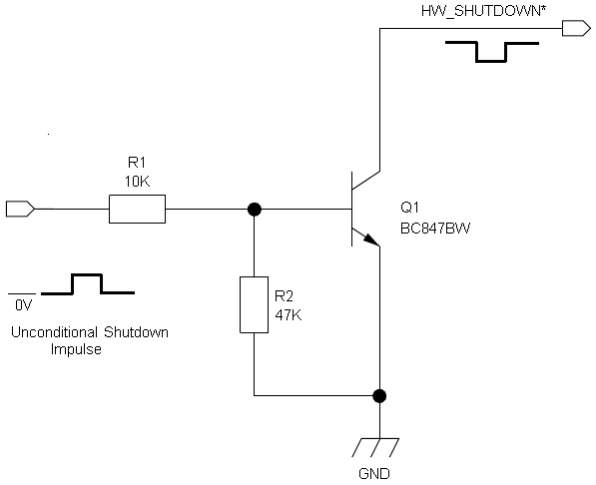
A typical circuit is the following:



For example:

1- Let us assume you need to drive the HW_SHUTDOWN* pad with a totem pole output of a +3/5 V microcontroller (uP_OUT2):



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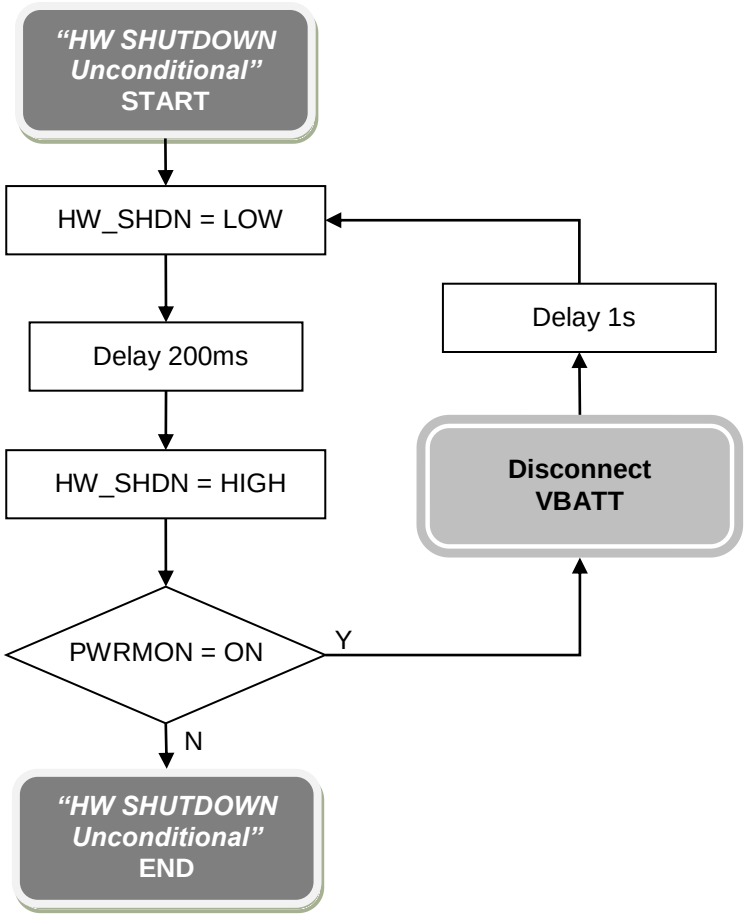
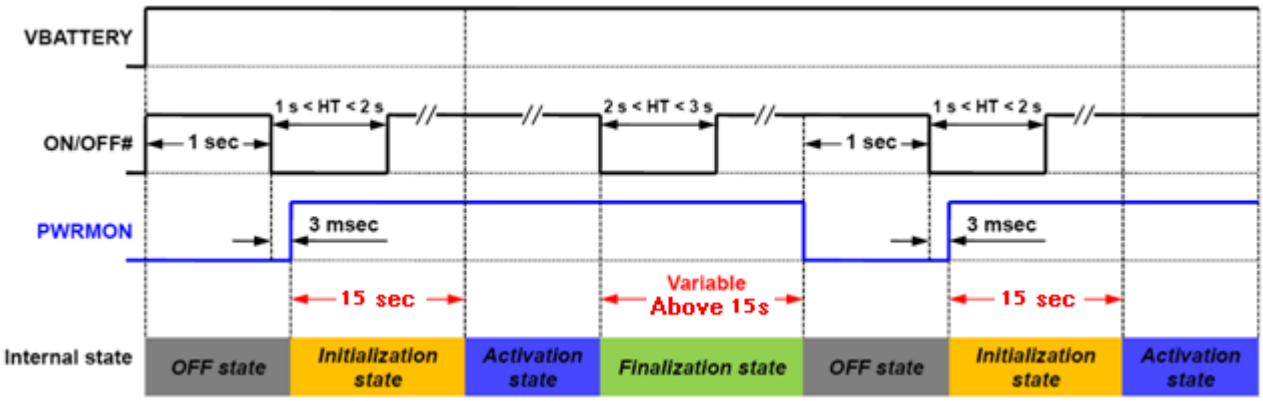
The below flow chart is describing the HW Shutdown procedure:



4.5 Summary of Turning ON and OFF the module

Below chart describes the overall sequences for Turning ON and OFF.



5 Power Supply

The power supply circuitry and board layout are a very important part in the full product design and they strongly reflect on the product overall performances, hence read carefully the requirements and the guidelines that will follow for a proper design.

5.1 Power Supply Requirements

The external power supply must be connected to VBATT & VBATT_PA signals and must fulfil the following requirements:

POWER SUPPLY	
Nominal Supply Voltage	3.8 V
Normal Operating Voltage Range	3.40 V÷ 4.20 V
Extended Operating Voltage Range	3.10 V÷ 4.35 V

NOTE:

The Operating Voltage Range MUST never be exceeded; care must be taken when designing the application's power supply section to avoid having an excessive voltage drop.

If the voltage drop is exceeding the limits it could cause a Power Off of the module.

The Power supply must be higher than 3.1 V to power on the module

NOTE:

Overshoot voltage (regarding MAX Extended Operating Voltage) and drop in voltage (regarding MIN Extended Operating Voltage) MUST never be exceeded;

The "Extended Operating Voltage Range" can be used only with completely assumption and application of the HW User guide suggestions.

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5.2 Power Consumption

LE910 current consumption			
Mode		**Average (mA)**	**Mode description**
SWITCHED OFF			Module supplied but Switched Off
Switched Off		68uA	
IDLE mode (GSM/EDGE)			
AT+CFUN=1	WCDMA	15	Normal mode: full functionality of the module
	GSM	19	
	LTE	20	
AT+CFUN=4		12	Disabled TX and RX; module is not registered on the network
AT+CFUN=5	WCDMA	1.8	Full functionality with power saving;
	GSM	1.9	
Operative mode (LTE)			
LTE (0dBm)		203	LTE data call (channel BW 5MHz, RB=1, TX=0dBm)
LTE (22dBm)		540	LTE data call (channel BW 5MHz, RB=1, TX=22dBm)
Operative mode (WCDMA)			
WCDMA Voice		202	WCDMA voice call (TX = 9dBm)
WCDMA HSDPA (0dBm)		137	WCDMA data call (RMC, TX = 0dBm)
WCDMA HSDPA (22dBm)		443	WCDMA data call (RMC, TX = 21dBm)
Operative mode (EDGE)			
EDGE 2TX+3RX			EDGE Sending data mode
LOW Band Gamma 7		218	
High Band Gamma 6		185	
Operative mode (GSM)			
GSM TX and RX mode			GSM VOICE CALL
LOW Band CSD PL5		223	
High Band CSD PL0		173	
GPRS 2TX+3RX			GPRS Sending data mode
LOW Band Max Power		394	
High Band Max Power		282	

NOTE: The electrical design for the Power supply should be made ensuring it will be capable of a peak current output of at least 2A if the LE910 supports GSM operation.

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5.3 General Design Rules

The principal guidelines for the Power Supply Design embrace three different design steps:

- the electrical design
- the thermal design
- the PCB layout.

5.3.1 Electrical Design Guidelines

The electrical design of the power supply depends strongly from the power source where this power is drained. We will distinguish them into three categories:

- +5V input (typically PC internal regulator output)
- +12V input (typically automotive)
- Battery

5.3.1.1 + 5V input Source Power Supply Design Guidelines

- The desired output for the power supply is 3.8V, hence there's not a big difference between the input source and the desired output and a linear regulator can be used. A switching power supply will not be suited because of the low drop out requirements.
- When using a linear regulator, a proper heat sink shall be provided in order to dissipate the power generated.
- A Bypass low ESR capacitor of adequate capacity must be provided in order to cut the current absorption peaks close to the LE910, a 100µF tantalum capacitor is usually suited.
- Make sure the low ESR capacitor on the power supply output (usually a tantalum one) is rated at least 10V.
- A protection diode should be inserted close to the power input, in order to save the LE910 from power polarity inversion.

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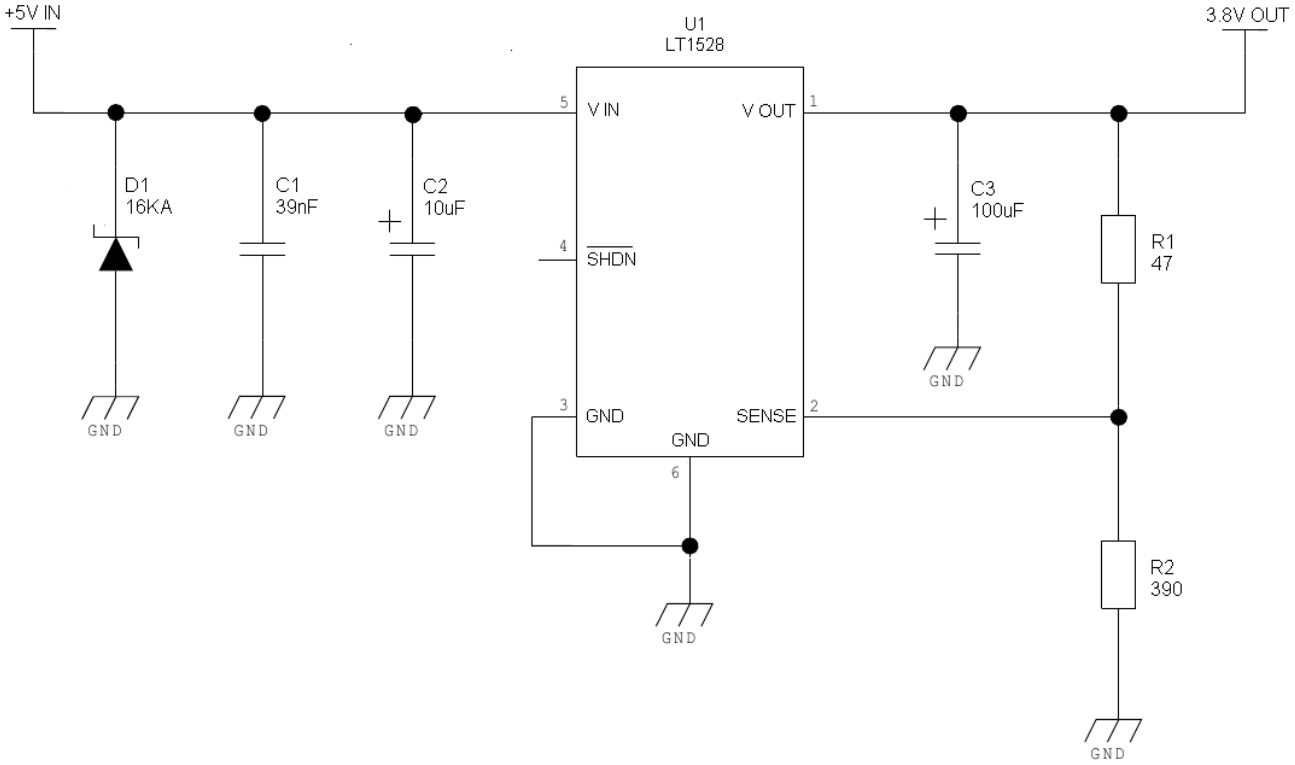
An example of linear regulator with 5V input is:



5.3.1.2 + 12V input Source Power Supply Design Guidelines

- The desired output for the power supply is 3.8V, hence due to the big difference between the input source and the desired output, a linear regulator is not suited and shall not be used. A switching power supply will be preferable because of its better efficiency especially with the 2A peak current load represented by the LE910.
- When using a switching regulator, a 500kHz or more switching frequency regulator is preferable because of its smaller inductor size and its faster transient response. This allows the regulator to respond quickly to the current peaks absorption.
- In any case the frequency and Switching design selection is related to the application to be developed due to the fact the switching frequency could also generate EMC interferences.
- For car PB battery the input voltage can rise up to 15,8V and this should be kept in mind when choosing components: all components in the power supply must withstand this voltage.
- A Bypass low ESR capacitor of adequate capacity must be provided in order to cut the current absorption peaks, a 100µF tantalum capacitor is usually suited.

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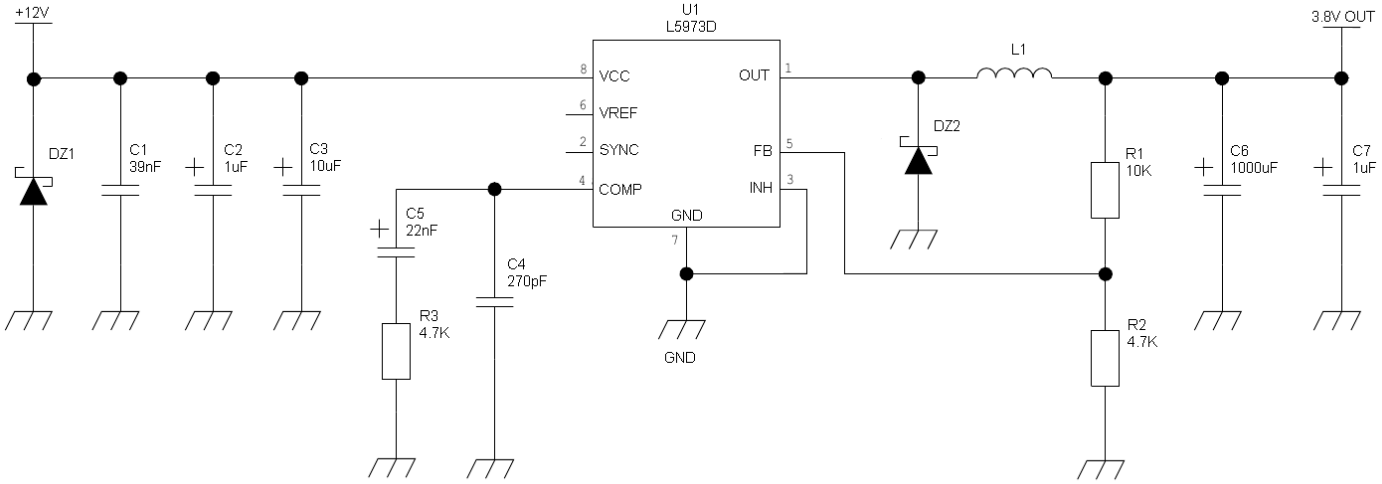
- Make sure the low ESR capacitor on the power supply output (usually a tantalum one) is rated at least 10V.
- For Car applications a spike protection diode should be inserted close to the power input, in order to clean the supply from spikes.
- A protection diode should be inserted close to the power input, in order to save the LE910 from power polarity inversion. This can be the same diode as for spike protection.

An example of switching regulator with 12V input is in the below schematic:



5.3.1.3 Battery Source Power Supply Design Guidelines

The desired nominal output for the power supply is 3.8V and the maximum voltage allowed is 4.2V, hence a single 3.7V Li-Ion cell battery type is suited for supplying the power to the Telit LE910 module.

WARNING:

The three cells Ni/Cd or Ni/MH 3,6 V Nom. Battery types or 4V PB types ***MUST NOT BE USED DIRECTLY*** since their maximum voltage can rise over the absolute maximum voltage for the LE910 and damage it.

NOTE:

DON'T USE any Ni-Cd, Ni-MH, and Pb battery types directly connected with LE910. Their use can lead to overvoltage on the LE910 and damage it. USE ONLY Li-Ion battery types.

- A Bypass low ESR capacitor of adequate capacity must be provided in order to cut the current absorption peaks, a 100µF tantalum capacitor is usually suited.
- Make sure the low ESR capacitor (usually a tantalum one) is rated at least 10V.
- A protection diode should be inserted close to the power input, in order to save the LE910 from power polarity inversion. Otherwise the battery connector should be done in a way to avoid polarity inversions when connecting the battery.
- The battery capacity must be at least 500mAh in order to withstand the current peaks of 2A; the suggested capacity is from 500mAh to 1000mAh.

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5.3.2 Thermal Design Guidelines

The thermal design for LE910 should be designed and tested in the following worse-case conditions at nominal voltage 3.80V:

- Average current consumption during LTE TX @PWR level max: 780mA
- Average current consumption during HSPA TX @PWR level max: 650mA
- Average current consumption during class12 EGPRS TX @PWR level max: 680mA
- In addition to one of the above current consumption, GNSS current should be added: 54 mA

NOTE:

The LE910 includes a function to prevent overheating.

5.3.3 Power Supply PCB layout Guidelines

As seen on the electrical design guidelines the power supply shall have a low ESR capacitor on the output to cut the current peaks and a protection diode on the input to protect the supply from spikes and polarity inversion. The placement of these components is crucial for the correct working of the circuitry. A misplaced component can be useless or can even decrease the power supply performances.

- The Bypass low ESR capacitor must be placed close to the Telit LE910 power input pads or in the case the power supply is a switching type it can be placed close to the inductor to cut the ripple provided the PCB trace from the capacitor to the LE910 is wide enough to ensure a dropless connection even during the 2A current peaks.

- The protection diode must be placed close to the input connector where the power source is drained.

- The PCB traces from the input connector to the power regulator IC must be wide enough to ensure no voltage drops occur when the 2A current peaks are absorbed. Note that this is not made in order to save power loss but especially to avoid the voltage drops on the power line at the current peaks frequency of 216 Hz that will reflect on all the components connected to that supply, introducing the noise floor at the burst base frequency. For this reason while a voltage drop of 300-400 mV may be acceptable from the power loss point of view, the same voltage drop may not be acceptable from the noise point of view. If your application doesn't have audio

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interface but only uses the data feature of the Telit LE910, then this noise is not so disturbing and power supply layout design can be more forgiving.

- The PCB traces to the LE910 and the Bypass capacitor must be wide enough to ensure no significant voltage drops occur when the 2A current peaks are absorbed. This is for the same reason as previous point. Try to keep this trace as short as possible.

- The PCB traces connecting the Switching output to the inductor and the switching diode must be kept as short as possible by placing the inductor and the diode very close to the power switching IC (only for switching power supply). This is done in order to reduce the radiated field (noise) at the switching frequency (100-500 kHz usually).

- The use of a good common ground plane is suggested.

- The placement of the power supply on the board should be done in such a way to guarantee that the high current return paths in the ground plane are not overlapped to any noise sensitive circuitry as the microphone amplifier/buffer or earphone amplifier.

- The power supply input cables should be kept separate from noise sensitive lines such as microphone/earphone cables.

- The insertion of EMI filter on VBATT pins is suggested in those designs where antenna is placed close to battery or supply lines.
  A ferrite bead like Murata BLM18EG101TN1 or Taiyo Yuden P/N FBMH1608HM101 can be used for this purpose.

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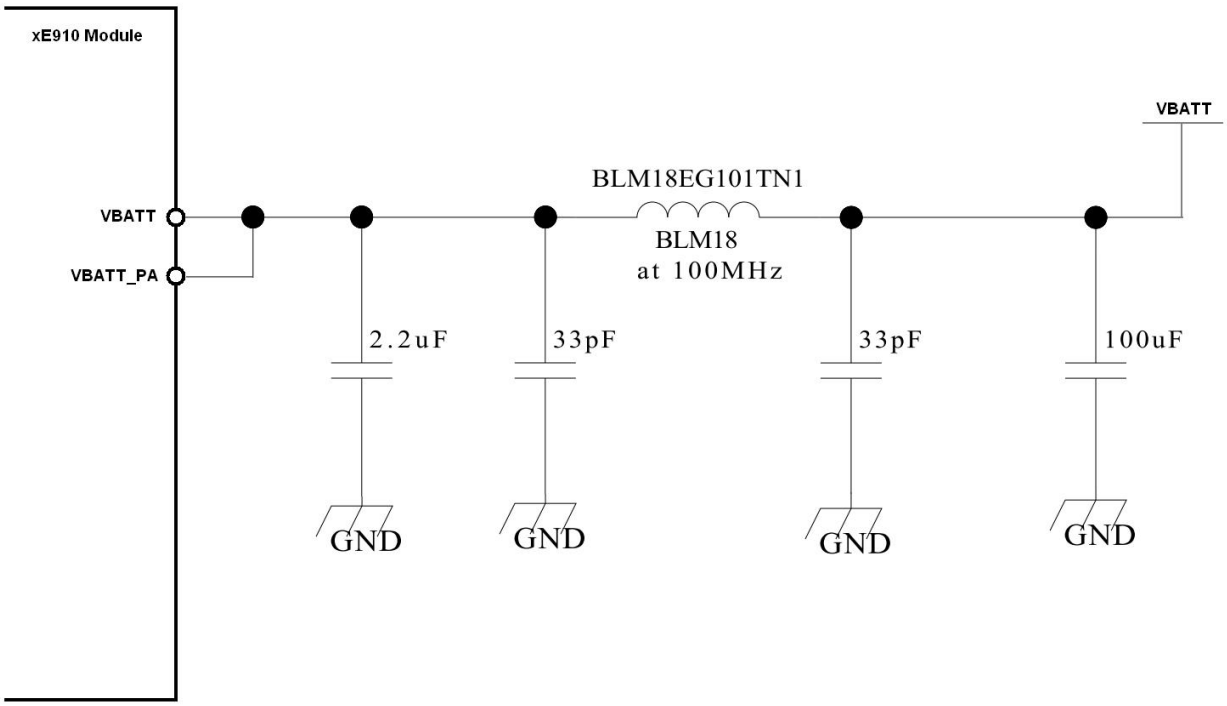
The below figure shows the recommended circuit:



6 GSM/WCDMA/LTE Radio Section

6.1 LE910 Product Variants

The following table is listing the main differences between the LE910 variants:

Product	Supported 2G Bands	Supported 3G bands	Supported LTE bands	GNSS
LE910-EUG	GSM 900, DCS1800	B5(850), B8 (900), B1 (2100)	B20 (800), B3 (1800), B7 (2600)	YES
LE910-NAG	GSM 850, PCS 1900	B5(850), B2(1900)	B17(700), B5(850), B4(1700), B2(1900)	YES
LE910-NVG	Not supported	B5(850), B2(1900)	B13(700), B4(1700)	YES
LE910-SVG	Not supported	Not supported	B13(700), B4(1700)	YES
LE910-SKG	Not supported	Not supported	B3 (1800), B5(850)	YES

6.2 TX Output Power

Band	Power Class
GSM 850 / 900	4 (2W)
DCS1800 / PCS 1900	1 (1W)
EDGE, 850/900 MHz	E2 (0.5W)
EDGE, 1800/1900 MHz	Class E2 (0.4W)
WCDMA FDD B1, B2, B4, B5, B8	Class 3 (0.25W)
LTE FDD B2, B3, B4, B5, B7, B13, B17, B20	Class 3 (0.2 W)

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6.3 Sensitivity

Band	Typical (dBm)	3GPP minimum requirements (dBm)	Note
GSM 850	-111.5	< -102.0	BER Class II <2.44% Single Receiver
GSM 900	-111.5	< -102.0	BER Class II <2.44% Single Receiver
DCS 1800	-110.5	< -102.0	BER Class II <2.44% Single Receiver
PCS 1900	-110.0	< -102.0	BER Class II <2.44% Single Receiver
WCDMA FDD B1	-115.0	< -106.7	BER <0.1% 12.2 Kbps Dual Receiver
WCDMA FDD B2	-114.5	< -104.7	BER <0.1% 12.2 Kbps Dual Receiver
WCDMA FDD B5	-115.0	< -106.7	BER <0.1% 12.2 Kbps Dual Receiver
WCDMA FDD B8	-114.5	< -103.7	BER <0.1% 12.2 Kbps Dual Receiver
LTE FDD B2	-103.0	< -94.3	Throughput >95% 10MHz Dual Receiver
LTE FDD B3	-102.5	< -93.3	Throughput >95% 10MHz Dual Receiver
LTE FDD B4	-102.5	< -96.3	Throughput >95% 10MHz Dual Receiver
LTE FDD B5	-103.0	< -94.3	Throughput >95% 10MHz Dual Receiver
LTE FDD B7	-100.5	< -94.3	Throughput >95% 10MHz Dual Receiver
LTE FDD B13	-101.5	< -93.3	Throughput >95% 10MHz Dual Receiver
LTE FDD B17	-101.5	< -94.3	Throughput >95% 10MHz Dual Receiver
LTE FDD B20	-102.5	< -93.3	Throughput >95% 10MHz Dual Receiver

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6.4 GSM/WCDMA/LTE Antenna Requirements

The antenna connection and board layout design are the most important aspect in the full product design as they strongly affect the product overall performances, hence read carefully and follow the requirements and the guidelines for a proper design.
The antenna and antenna transmission line on PCB for a Telit LE910 device shall fulfil the following requirements:

ANTENNA REQUIREMENTS for LE910-EUG	
Frequency range	Depending by frequency band(s) provided by the network operator, the customer shall use the most suitable antenna for that/those band(s)
Bandwidth (GSM/EDGE)	GSM900 : 80 MHz GSM1800(DCS) : 170 MHz
Bandwidth (WCDMA)	WCDMA band I(2100) : 250 MHz WCDMA band V(850) : 70 MHz WCDMA band VIII(900) : 80 MHz
Bandwidth (LTE)	LTE band III(1800) : 170 MHz LTE Band VII(2600) : 190 MHz LTE Band XX(800) : 71 MHz
Impedance	50 ohm
Input power	> 33dBm(2 W) peak power in GSM > 24dBm Average power in WCDMA & LTE
VSWR absolute max	≤ 10:1 (limit to avoid permanent damage)
VSWR recommended	≤ 2:1 (limit to fulfil all regulatory requirements)

ANTENNA REQUIREMENTS for LE910-NAG	
Frequency range	Depending by frequency band(s) provided by the network operator, the customer shall use the most suitable antenna for that/those band(s)
Bandwidth (GSM/EDGE)	GSM850 : 70 MHz GSM1900(PCS) : 140 MHz
Bandwidth (WCDMA)	WCDMA band II(1900) : 140 MHz WCDMA band V(850) : 70 MHz
Bandwidth (LTE)	LTE Band II(1900) : 140 MHz LTE Band IV(1700) : 445 MHz LTE Band V (850) : 70 MHz LTE Band XVII(700) : 42 MHz
Impedance	50 ohm
Input power	> 33dBm(2 W) peak power in GSM > 24dBm Average power in WCDMA & LTE
VSWR absolute max	≤ 10:1 (limit to avoid permanent damage)
VSWR recommended	≤ 2:1 (limit to fulfil all regulatory requirements)

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ANTENNA REQUIREMENTS for LE910-NVG	
Frequency range	Depending by frequency band(s) provided by the network operator, the customer shall use the most suitable antenna for that/those band(s)
Bandwidth (WCDMA)	WCDMA band II(1900) : 140 MHz WCDMA band V(850) : 70 MHz
Bandwidth (LTE)	LTE Band IV(1700) : 445 MHz LTE Band XIII(700) : 41 MHz
Impedance	50 ohm
Input power	> 24dBm Average power in WCDMA & LTE
VSWR absolute max	≤ 10:1 (limit to avoid permanent damage)
VSWR recommended	≤ 2:1 (limit to fulfil all regulatory requirements)

ANTENNA REQUIREMENTS for LE910-SVG	
Frequency range	Depending by frequency band(s) provided by the network operator, the customer shall use the most suitable antenna for that/those band(s)
Bandwidth (LTE)	LTE Band IV(1700) : 445 MHz LTE Band XIII(700) : 41 MHz
Impedance	50 ohm
Input power	> 24dBm Average power
VSWR absolute max	≤ 10:1 (limit to avoid permanent damage)
VSWR recommended	≤ 2:1 (limit to fulfil all regulatory requirements)

ANTENNA REQUIREMENTS for LE910-SKG	
Frequency range	Depending by frequency band(s) provided by the network operator, the customer shall use the most suitable antenna for that/those band(s)
Bandwidth (LTE)	LTE band III(1800) : 170 MHz LTE Band V (850) : 70 MHz
Impedance	50 ohm
Input power	> 24dBm Average power
VSWR absolute max	≤ 10:1 (limit to avoid permanent damage)
VSWR recommended	≤ 2:1 (limit to fulfil all regulatory requirements)

When using the LE910, since there's no antenna connector on the module, the antenna must be connected to the LE910 antenna pad (K1) by means of a transmission line implemented on the PCB.

In the case the antenna is not directly connected at the antenna pad of the LE910, then a PCB line is needed in order to connect with it or with its connector.

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This transmission line shall fulfil the following requirements:

ANTENNA LINE ON PCB REQUIREMENTS	
Characteristic Impedance	50 ohm
Max Attenuation	0,3 dB
Coupling with other signals shall be avoided	
Cold End (Ground Plane) of antenna shall be equipotential to the LE910 ground pins	

Furthermore if the device is developed for the US market and/or Canada market, it shall comply with the FCC and/or IC approval requirements:
This device is to be used only for mobile and fixed application. In order to re-use the Telit FCC/IC approvals the antenna(s) used for this transmitter must be installed to provide a separation distance of at least 20 cm from all persons and must not be co-located or operating in conjunction with any other antenna or transmitter. If antenna is installed with a separation distance of less than 20 cm from all persons or is co-located or operating in conjunction with any other antenna or transmitter then additional FCC/IC testing may be required. End-Users must be provided with transmitter operation conditions for satisfying RF exposure compliance.
Antennas used for this OEM module must not exceed the gains for mobile and fixed operating configurations as described in “FCC/IC Regulatory notices” chapter.

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6.5 GSM/WCDMA/LTE - PCB line Guidelines

- Make sure that the transmission line's characteristic impedance is 50ohm ;
- Keep line on the PCB as short as possible, since the antenna line loss shall be less than around 0,3 dB;
- Line geometry should have uniform characteristics, constant cross section, avoid meanders and abrupt curves;
- Any kind of suitable geometry / structure (Microstrip, Stripline, Coplanar, Grounded Coplanar Waveguide...) can be used for implementing the printed transmission line afferent the antenna;
- If a Ground plane is required in line geometry, that plane has to be continuous and sufficiently extended, so the geometry can be as similar as possible to the related canonical model;
- Keep, if possible, at least one layer of the PCB used only for the Ground plane; If possible, use this layer as reference Ground plane for the transmission line;
- It is wise to surround (on both sides) the PCB transmission line with Ground, avoid having other signal tracks facing directly the antenna line track.
- Avoid crossing any un-shielded transmission line footprint with other signal tracks on different layers;
- The ground surrounding the antenna line on PCB has to be strictly connected to the main Ground Plane by means of via holes (once per 2mm at least), placed close to the ground edges facing line track;
- Place EM noisy devices as far as possible from LE910 antenna line;
- Keep the antenna line far away from the LE910 power supply lines;
- If EM noisy devices (such as fast switching ICs, LCD and so on) are present on the PCB hosting the LE910, take care of the shielding of the antenna line by burying it in an inner layer of PCB and surround it with Ground planes, or shield it with a metal frame cover.
- If EM noisy devices are not present around the line, the use of geometries like Microstrip or Grounded Coplanar Waveguide has to be preferred, since they typically ensure less attenuation if compared to a Stripline having same length;

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6.6 GSM/WCDMA/LTE Antenna - Installation Guidelines

- Install the antenna in a place covered by the GSM signal.
- Antenna must not be installed inside metal cases
- Antenna shall also be installed according Antenna manufacturer instructions
- Antenna integration should optimize the Radiation Efficiency. Efficiency values > 50% are recommended on all frequency bands.
- Antenna integration should not dramatically perturb the radiation pattern. It is preferable to get, after antenna installation, an omnidirectional radiation pattern, at least in one pattern cut
- Antenna Gain must not exceed values indicated in regulatory requirements, where applicable, in order to meet related EIRP limitations. Typical antenna Gain in most M2M applications does not exceed 2dBi.
- If the device antenna is located greater than 20cm from the human body and there are no co-located transmitter then the Telit FCC/IC approvals can be re-used by the end product
- If the device antenna is located less than 20cm from the human body or there are no co-located transmitter then the additional FCC/IC testing may be required for the end product (Telit FCC/IC approvals cannot be reused)

6.7 Antenna Diversity Requirements

This product is including an input for a second RX antenna to improve the data throughput.
The function is called Antenna Diversity in WCDMA mode and downlink MIMO in LTE mode.

DIVERSITY ANTENNA REQUIREMENTS for LE910-EUG	
Frequency range	Depending by frequency band(s) provided by the network operator, the customer shall use the most suitable antenna for that/those band(s)
Bandwidth (WCDMA)	WCDMA band I(2100) : 60 MHz WCDMA band V(850) : 25 MHz WCDMA band VIII(900) : 35 MHz
Bandwidth (LTE)	LTE band III(1800) : 75 MHz LTE Band VII(2600) : 70 MHz LTE Band XX(800) : 30 MHz
Impedance	50 ohm
VSWR recommended	≤ 2:1 (recommended for best sensitivity performance)

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DIVERSITY ANTENNA REQUIREMENTS for LE910-NAG	
Frequency range	Depending by frequency band(s) provided by the network operator, the customer shall use the most suitable antenna for that/those band(s)
Bandwidth (WCDMA)	WCDMA band II(1900) : 60 MHz WCDMA band V(850) : 25 MHz
Bandwidth (LTE)	LTE Band II(1900) : 60 MHz LTE Band IV(1700) : 45 MHz LTE Band V (850) : 25 MHz LTE Band XVII(700) : 12 MHz
Impedance	50 ohm
VSWR recommended	≤ 2:1 (recommended for best sensitivity performance)

DIVERSITY ANTENNA REQUIREMENTS for LE910-NVG	
Frequency range	Depending by frequency band(s) provided by the network operator, the customer shall use the most suitable antenna for that/those band(s)
Bandwidth (WCDMA)	WCDMA band II(1900) : 60 MHz WCDMA band V(850) : 25 MHz
Bandwidth (LTE)	LTE Band IV(1700) : 45 MHz LTE Band XIII(700) : 10 MHz
Impedance	50 ohm
VSWR recommended	≤ 2:1 (recommended for best sensitivity performance)

DIVERSITY ANTENNA REQUIREMENTS for LE910-SVG	
Frequency range	Depending by frequency band(s) provided by the network operator, the customer shall use the most suitable antenna for that/those band(s)
Bandwidth (LTE)	LTE Band IV(1700) : 45 MHz LTE Band XIII(700) : 10 MHz
Impedance	50 ohm
VSWR recommended	≤ 2:1 (recommended for best sensitivity performance)

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DIVERSITY ANTENNA REQUIREMENTS for LE910-SKG	
Frequency range	Depending by frequency band(s) provided by the network operator, the customer shall use the most suitable antenna for that/those band(s)
Bandwidth (LTE)	LTE band III(1800) : 75 MHz LTE Band V (850) : 25 MHz
Impedance	50 ohm
VSWR recommended	≤ 2:1 (recommended for best sensitivity performance)

When using the LE910, since there's no antenna connector on the module, the antenna must be connected to the LE910 antenna pad (F1) by means of a transmission line implemented on the PCB.

In the case the antenna is not directly connected at the antenna pad of the LE910, then a PCB line is needed in order to connect with it or with its connector.

The second Rx antenna should not be located in the close vicinity of main antenna. In order to improve Diversity Gain, Isolation and reduce mutual interaction, the two antennas should be located at the maximum reciprocal distance possible, taking into consideration the available space into the application. For the same reason, the Rx antenna should also be cross-polarized with respect to the main antenna.
Isolation between main antenna and Rx antenna must be at least 10 dB in all uplink frequency bands.
Envelope Correlation Coefficient (ECC) value should be as close as possible to zero, for best diversity performance. ECC values below 0.5 on all frequency bands are recommended.

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7 GNSS Receiver

The LE910 module is integrating a GNSS receiver that could be used in Autonomous or in A-GPS (assisted GPS) mode.
The LE910 module includes an embedded LNA (13.5dB gain typ.) with front-end filter and inter-stage filter in order to connect directly a passive antenna connected to ANT_GNSS pad.
In case of external antenna connection, proper DC-decoupling and ESD protection must be inserted to ANT_GNSS pad.

7.1 Receiver Characteristics

Cold Start Sensitivity	-145 dBm
Hot Start Sensitivity	-156 dBm
Tracking Sensibility	-161 dBm
Navigation Sensitivity	-159 dBm
TTFF (Cold Start)	31.5 s
TTFF (Hot Start)	1.3 s
Position Accuracy	0.4 m (CEP 100, static scenario, -130dBm, hot start)

7.2 GNSS Signals Pinout

The Pads related to this function are the following:

PAD	Signal	I/O	Function	Type
R9	ANT_GNSS	I	GNSS Antenna (50 ohm)	RF
R7	GNSS_LNA_EN	O	Output enable for External LNA supply	CMOS 1.8V

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7.3 GPS/GLONASS Antenna Requirements

GPS/GLONASS ANTENNA REQUIREMENTS for LE910	
Frequency range	1575.42 MHz ±2MHz (GPS) 1598.0625 – 1607.0625 MHz (GLONASS)
Average Gain over direction	>-5dBi
Polarization	RHCP (recommended) Linear (acceptable) Avoid the use of LHCP antennas
Impedance	50 ohm
VSWR recommended	≤ 2:1 (recommended for best sensitivity performance)

7.3.1 GNSS Antenna - PCB Line Guidelines

- Ensure that the antenna line impedance is 50ohm.
- Keep the antenna line on the PCB as short as possible to reduce the loss.
- Antenna line must have uniform characteristics, constant cross section, avoid meanders and abrupt curves.
- Keep one layer of the PCB used only for the Ground plane, if possible.
- Surround (on the sides, over and under) the antenna line on PCB with Ground, avoid having other signal tracks facing directly the antenna line of track.
- The ground around the antenna line on PCB has to be strictly connected to the Ground Plane by placing vias once per 2mm at least.
- Place EM noisy devices as far as possible from LE910 antenna line.
- Keep the antenna line far away from the LE910 power supply lines.
- Keep the antenna line far away from the LE910 GSM RF lines.
- If you have EM noisy devices around the PCB hosting the LE910, such as fast switching ICs, LCD and so on, take care of the shielding of the antenna line by routing it in an inner layer of PCB and surround it with Ground planes, or shield it with a metal frame cover.
- If you do not have EM noisy devices around the PCB of LE910, use for the antenna line a microstrip or G-CPW line on an outer layer of the PCB, since in this case the line attenuation is lower in comparison to a buried one.

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7.3.2 RF Trace Losses

RF Trace losses are difficult to estimate on a PCB without having the appropriate tables or RF simulation software to estimate what the losses would be. A good rule of thumb would be to keep the RF traces as short as possible, make sure they are 50 ohms impedance and don't contain any sharp bends.

7.3.3 GNSS Antenna - Installation

- The LE910 due to its characteristics of sensitivity is capable to perform a Fix inside the buildings. (In any case the sensitivity could be affected by the building characteristics i.e. shielding).
- The Antenna must not be co-located or operating in conjunction with any other antenna or transmitter. The isolation between GPS/GNSS antenna and main GSM/WCDMA/LTE antenna must be at least 10 dB in all uplink bands.
- Antenna must not be installed inside metal cases.
- Antenna must be installed also according to the Antenna manufacturer instructions.

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8 Logic level specifications

The following table shows the logic level specifications used in the LE910 interface circuits:

Absolute Maximum Ratings -Not Functional

Parameter	Min	Max
Input level on any digital pin (CMOS 1.8) with respect to ground	-0.3V	2.16V

Operating Range - Interface levels (1.8V CMOS)

Level	Min	Max
Input high level	1.5V	2.1V
Input low level	0V	0.5V
Output high level	1.35V	1.8
Output low level	0V	0.45V

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9 Unconditional Shutdown

Signal	Function	I/O	PAD
HW_SHUTDOWN*	Unconditional Shutdown of the Module	I	R13

HW_SHUTDOWN* is used to unconditionally shutdown the LE910. Whenever this signal is pulled low, the LE910 is reset. When the device is reset it stops any operation. After the release of the line, the LE910 is unconditionally shut down, without doing any detach operation from the network where it is registered. This behaviour is not a proper shut down because any GSM device is requested to issue a detach request on turn off. For this reason the HW_SHUTDOWN* signal must not be used to normally shutting down the device, but only as an emergency exit in the rare case the device remains stuck waiting for some network response.
The HW_SHUTDOWN* is internally controlled on start-up to achieve always a proper power-on reset sequence, so there's no need to control this pin on start-up.
It may only be used to reset a device already on that is not responding to any command.

NOTE:

Do not use this signal to power off the LE910. Use the ON/OFF signal to perform this function or the AT#SHDN command.

Unconditional Shutdown Signal Operating levels:

Signal	Min	Max
HW_SHUTDOWN* Input high	1.5V	2.1V
HW_SHUTDOWN* Input low	0V	0.5V

* this signal is internally pulled up so the pin can be left floating if not used.

If unused, this signal may be left unconnected. If used, then it **must always be connected with an open collector transistor**, to permit to the internal circuitry the power on reset and under voltage lockout functions.

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10 USB Port

The LE910 module includes a Universal Serial Bus (USB) transceiver 2.0, which operates at USB high-speed (480Mbits/sec) and is compatible with older USB full-speed (12Mbits/sec).

10.1 USB 2.0 HS Description

The following table is listing the available signals:

PAD	Signal	I/O	Function	Type	NOTE
B15	USB_D+	I/O	USB differential Data (+)	3.3V	
C15	USB_D-	I/O	USB differential Data (-)	3.3V	
A13	VUSB	AI	Power sense to activate internal USB transceiver.	5V	USB active: 2.0 V to 5.25 V with nternal pull-down 10K

The USB_DPLUS and USB_DMINUS signals have a clock rate of 480 MHz.

The signal traces should be routed carefully. Trace lengths, number of vias and capacitive loading should be minimized, additional ESD protection must be carefully evaluated.

The characteristic impedance value should be as close as possible to 90 Ohms differential.

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11 Serial Ports

The LE910 module is provided with by 2 Asynchronous serial ports:

- MODEM SERIAL PORT 1 (Main)
- MODEM SERIAL PORT 2 (Auxiliary)

Several configurations can be designed for the serial port on the OEM hardware, but the most common are:

- RS232 PC com port
- microcontroller UART @ 1.8V (Universal Asynchronous Receive Transmit)
- microcontroller UART @ 5V or other voltages different from 1.8V

Depending from the type of serial port on the OEM hardware a level translator circuit may be needed to make the system work.
On the LE910 the ports are CMOS 1.8.

The electrical characteristics of the Serial ports are explained in the following tables:

Absolute Maximum Ratings -Not Functional

Parameter	Min	Max
Input level on any digital pin (CMOS 1.8) with respect to ground	-0.3V	2.16V

Operating Range - Interface levels (1.8V CMOS)

Level	Min	Max
Input high level	1.5V	2.1V
Input low level	0V	0.5V
Output high level	1.35V	1.8
Output low level	0V	0.45V

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11.1 MODEM SERIAL PORT 1

The serial port 1 on the LE910 is a +1.8V UART with all the 7 RS232 signals.
It differs from the PC-RS232 in the signal polarity (RS232 is reversed) and levels.

RS232 Pin #	Signal	LE910 Pad Number	Name	Usage
1	C109/DCD	**N14**	Data Carrier Detect	Output from the LE910 that indicates the carrier presence
2	C104/RXD	**M15**	Transmit line *see Note	Output transmit line of LE910 UART
3	C103/TXD	**N15**	Receive line *see Note	Input receive of the LE910 UART
4	C108/DTR	**M14**	Data Terminal Ready	Input to the LE910 that controls the DTE READY condition
5	GND	**M12, B13, P13, E14 …**	Ground	Ground
6	C107/DSR	**P14**	Data Set Ready	Output from the LE910 that indicates the module is ready
7	C106/CTS	**P15**	Clear to Send	Output from the LE910 that controls the Hardware flow control
8	C105/RTS	**L14**	Request to Send	Input to the LE910 that controls the Hardware flow control
9	C125/RING	**R14**	Ring Indicator	Output from the LE910 that indicates the incoming call condition

NOTE:

According to V.24, some signal names are referred to the application side, therefore on the LE910 side these signal are on the opposite direction:
TXD on the application side will be connected to the receive line (here named C103/TXD)
RXD on the application side will be connected to the transmit line (here named C104/RXD)

NOTE:

For a minimum implementation, only the TXD, RXD lines can be connected, the other lines can be left open provided a software flow control is implemented.

NOTE:

In order to avoid a back powering effect it is recommended to avoid having any HIGH logic level signal applied to the digital pins of the LE910 when the module is powered off or during an ON/OFF transition.

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11.2 MODEM SERIAL PORT 2 (USIF1)

The secondary serial port on the LE910 is composed by only the RX and TX lines.
The signals of the LE910 serial port are:

PAD	Signal	I/O	Function	Type	COMMENT
D15	TX_AUX	O	Auxiliary UART (TX Data to DTE)	1.8V	
E15	RX_AUX	I	Auxiliary UART (RX Data from DTE)	1.8V	

NOTE:

In order to avoid a back powering effect it is recommended to avoid having any HIGH logic level signal applied to the digital pins of the LE910 when the module is powered off or during an ON/OFF transition.

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11.3 RS232 level translation

In order to interface the LE910 with a PC com port or a RS232 (EIA/TIA-232) application a level translator is required. This level translator must:

- invert the electrical signal in both directions;
- Change the level from 0/1.8V to +15/-15V.

Actually, the RS232 UART 16450, 16550, 16650 & 16750 chipsets accept signals with lower levels on the RS232 side (EIA/TIA-562), allowing a lower voltage-multiplying ratio on the level translator. Note that the negative signal voltage must be less than 0V and hence some sort of level translation is always required.
The simplest way to translate the levels and invert the signal is by using a single chip level translator. There are a multitude of them, differing in the number of drivers and receivers and in the levels (be sure to get a true RS232 level translator not a RS485 or other standards).
By convention the driver is the level translator from the 0-1.8V UART to the RS232 level. The receiver is the translator from the RS232 level to 0-1.8V UART.

In order to translate the whole set of control lines of the UART you will need:

- 5 drivers
- 3 receivers

NOTE:

Avoid any overvoltage condition on digital pins.

VAUX can be used (always active during LE910 operation) for any level translation or pullup/pulldown on digital pins.

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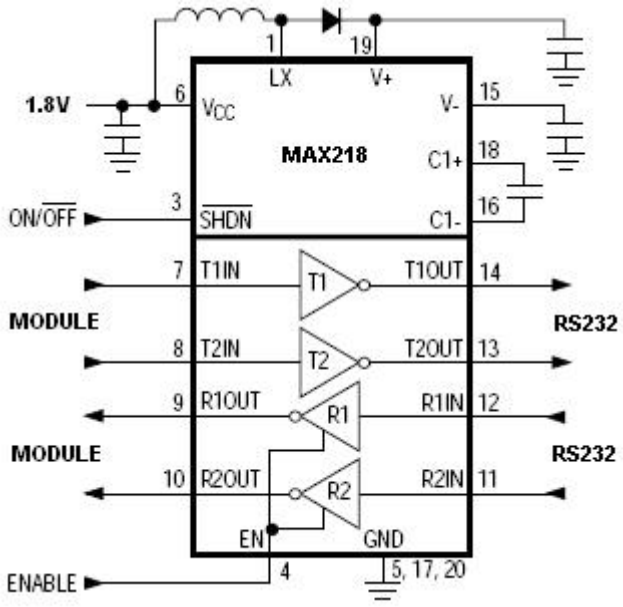
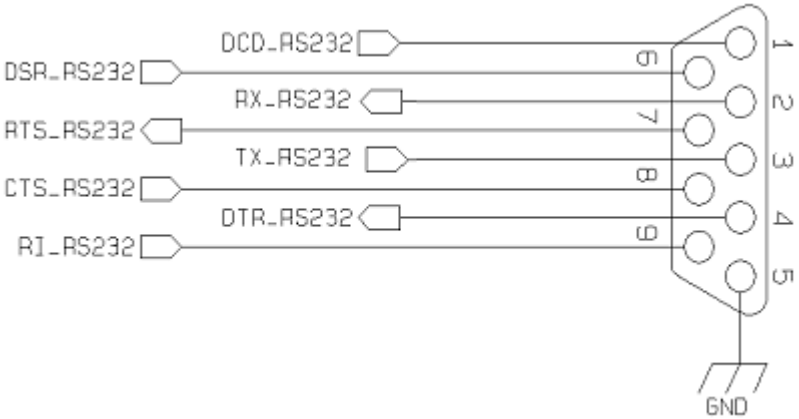
An example of RS232 level adaptation circuitry could be done using a MAXIM transceiver (MAX218)
In this case the chipset is capable to translate directly from 1.8V to the RS232 levels (Example done on 4 signals only).



NOTE:

In this case the length of the lines on the application has to be carefully checked to avoid problems in case of High Speed data rates on RS232.

The RS232 serial port lines are usually connected to a DB9 connector with the following layout:



12 Audio Section Overview

The Audio of the LE910 Module is carried by DVI digital audio interface.
The audio port can be directly connected to end device using digital interface, or via one of the several compliant codecs (in case an analog audio is needed).

12.1 Electrical Characteristics

The product is providing the Digital Audio Interface (DVI) on the following Pins:

Digital Voice Interface (DVI)					
PAD	**Signal**	**I/O**	**Function**	**Note**	**Type**
B9	DVI_WA0	I/O	Digital Audio Interface (WA0)		B-PD 1.8V
B6	DVI_RX	I	Digital Audio Interface (RX)		B-PD 1.8V
B7	DVI_TX	O	Digital Audio Interface (TX)		B-PD 1.8V
B8	DVI_CLK	I/O	Digital Audio Interface (BCLK)		B-PD 1.8V

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13 General Purpose I/O

The LE910 module is provided by a set of Digital Input / Output pins

Input pads can only be read; they report the digital value (high or low) present on the pad at the read time.
Output pads can only be written or queried and set the value of the pad output.
An alternate function pad is internally controlled by the LE910 firmware and acts depending on the function implemented.

The following table shows the available GPIO on the LE910:

PAD	Signal	I/O	Function	Type	Drive strength	Note
C8	GPIO_01	I/O	Configurable GPIO	BH-PD (*) 1.8V	**1** mA	
C9	GPIO_02	I/O	Configurable GPIO	BH-PD (*) 1.8V	**1** mA	
C10	GPIO_03	I/O	Configurable GPIO	BH-PD (*) 1.8V	**1** mA	
C11	GPIO_04	I/O	Configurable GPIO	BH-PD (*) 1.8V	**1** mA	
B14	GPIO_05	I/O	Configurable GPIO	BH-PD (*) 1.8V	**1** mA	
C12	GPIO_06	I/O	Configurable GPIO	BH-PD (*) 1.8V	**1** mA	
C13	GPIO_07	I/O	Configurable GPIO	BH-PD (*) 1.8V	**1** mA	
K15	GPIO_08	I/O	Configurable GPIO	BH-PD (*) 1.8V	**1** mA	
L15	GPIO_09	I/O	Configurable GPIO	BH-PD (*) 1.8V	**1** mA	
G15	GPIO_10	I/O	Configurable GPIO	BH-PD (*) 1.8V	**1** mA	

(*) **BH-PD** - Bidirectional digital with CMOS input; High-voltage tolerant; Contains an internal pull-down device.

NOTE:

In order to avoid a back powering effect it is recommended to avoid having any HIGH logic level signal applied to the digital pins of the LE910 when the module is powered off or during an ON/OFF transition.

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13.1 GPIO Logic levels

Where not specifically stated, all the interface circuits work at 1.8V CMOS logic levels.
The following table shows the logic level specifications used in the LE910 interface circuits:

Absolute Maximum Ratings -Not Functional

Parameter	Min	Max
Input level on any digital pin (CMOS 1.8) with respect to ground	-0.3V	2.16V

Operating Range - Interface levels (1.8V CMOS)

Level	Min	Max
Input high level	1.5V	2.1V
Input low level	0V	0.5V
Output high level	1.35V	1.8
Output low level	0V	0.45V

13.2 Using a GPIO Pad as INPUT

The GPIO pads, when used as inputs, can be connected to a digital output of another device and report its status, provided this device has interface levels compatible with the 1.8V CMOS levels of the GPIO. If the digital output of the device to be connected with the GPIO input pad has interface levels different from the 1.8V CMOS, then it can be buffered with an open collector transistor with a 10K pull up to 1.8V.

NOTE:

In order to avoid a back powering effect it is recommended to avoid having any HIGH logic level signal applied to the digital pins of the LE910 when the module is powered off or during an ON/OFF transition.

13.3 Using a GPIO Pad as OUTPUT

The GPIO pads, when used as outputs, can drive 1.8V CMOS digital devices or compatible hardware. When set as outputs, the pads have a push-pull output and therefore the pull-up resistor may be omitted.

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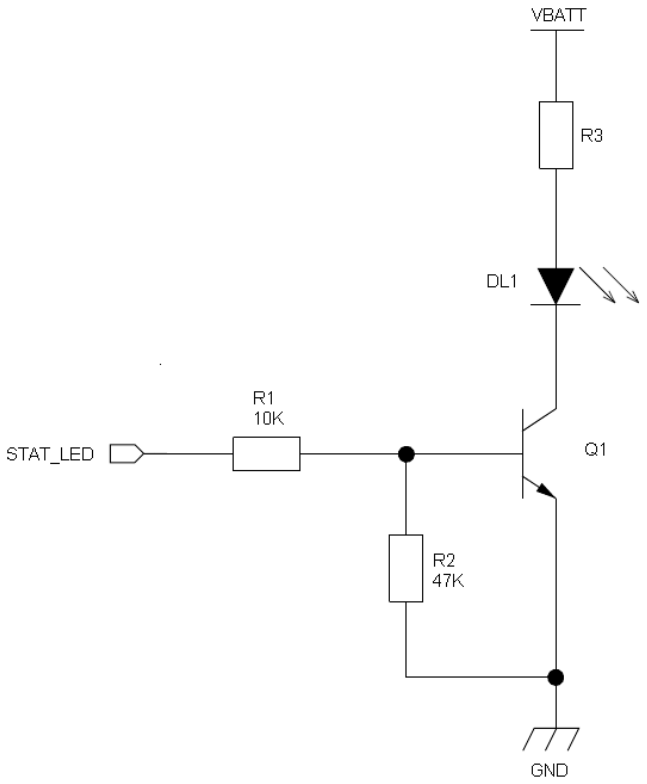
13.4 Indication of network service availability

The STAT_LED pin status shows information on the network service availability and Call status. The function is available as alternate function of GPIO_01 (to be enabled using the AT#GPIO=1,0,2 command).
In the LE910 modules, the STAT_LED needs an external transistor to drive an external LED. Therefore, the status indicated in the following table is reversed with respect to the pin status.

Device Status	LED status
Device off	Permanently off
Not Registered	Permanently on
Registered in Idle	Blinking (Period 1s on + 2s off)
Registered in Idle + Power Saving	Depends on the event that triggers the wakeup (in sync with network Paging)
Voice Call Active	Permanently on
Dial-Up	Blinking (Period 1s on + 2s off)

A schematic example could be:



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13.5 RTC Bypass out

The VRTC pin brings out the Real Time Clock supply, which is separate from the rest of the digital part, allowing having only RTC going on when all the other parts of the device are off. To this power output a backup capacitor can be added in order to increase the RTC autonomy during power off of the battery.

NO Devices must be powered from this pin.

13.6 VAUX Power Output

A regulated power supply output is provided in order to supply small devices from the module. The signal is present on Pad R11 and it is in common with the PWRMON (module powered ON indication) function.
This output is always active when the module is powered ON.

The operating range characteristics of the supply are:

Level	Min	Typical	Max
Output voltage	1.75V	1.80V	1.85V
Output current	-	-	100mA
Output bypass capacitor (inside the module)			1uF

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13.7 ADC Converter

13.7.1 Description

The LE910 is provided by one AD converter.
It is able to read a voltage level in the range of 0÷1.7 volts applied on the ADC pin input, store and convert it into 8 bit word.
The following table is showing the ADC characteristics:

	Min	Max	Units
Input Voltage range	0	1.7	Volt
AD conversion	-	8	bits
Resolution	-	< 6,6	mV

The input line is named as **ADC_IN1** and it is available on Pad **B1**

13.7.2 Using ADC Converter

An AT command is available to use the ADC function.

The command is ***AT#ADC=1,2***

The read value is expressed in mV

Refer to SW User Guide or AT Commands Reference Guide for the full description of this function.

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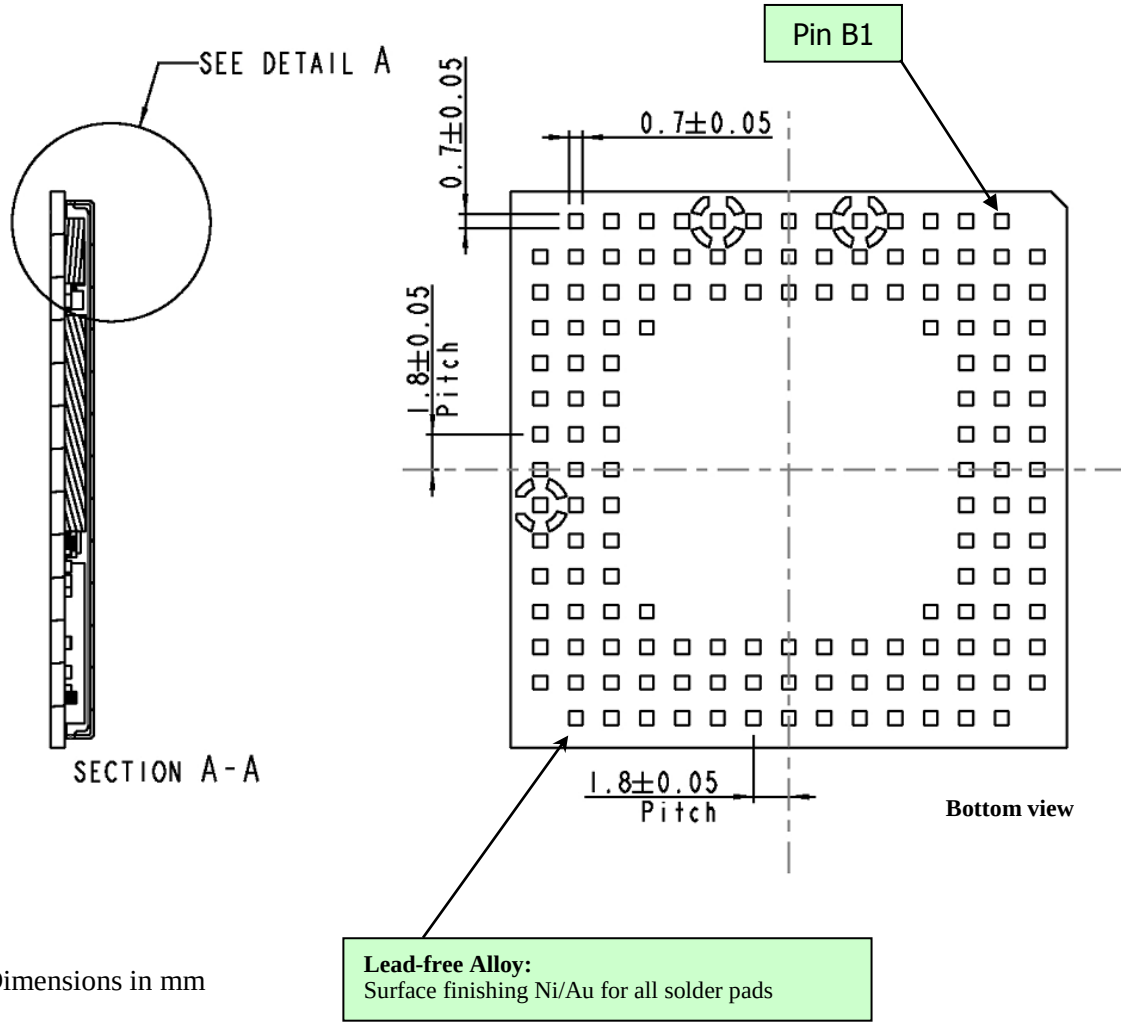
14 Mounting the LE910 on the application

14.1 General

The LE910 modules have been designed in order to be compliant with a standard lead-free SMT process.

14.2 Module finishing & dimensions



Dimensions in mm

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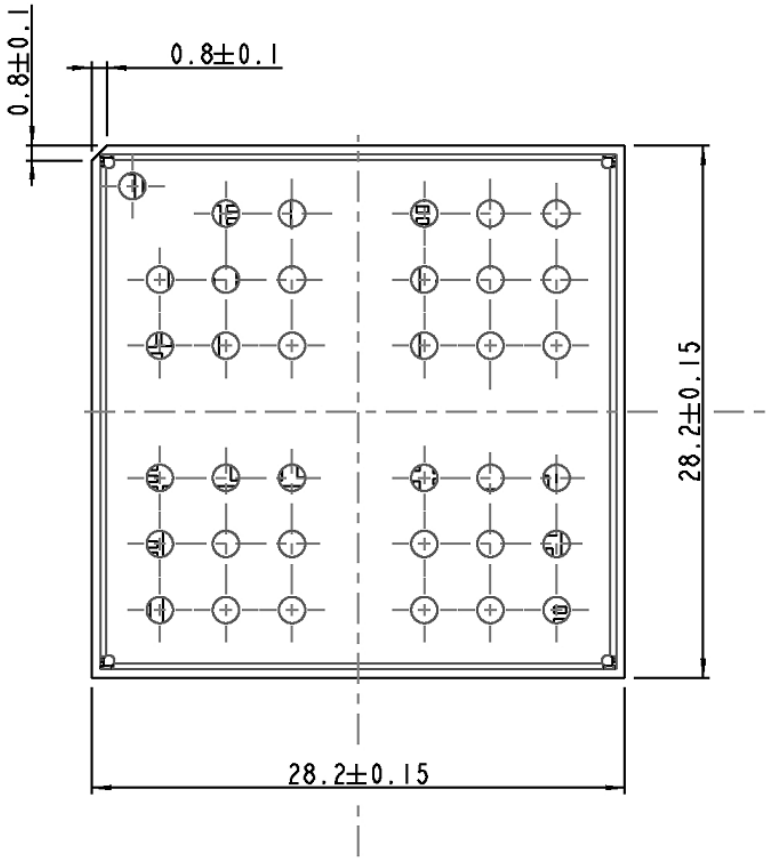
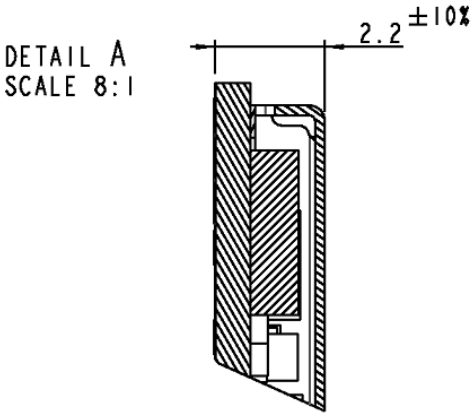
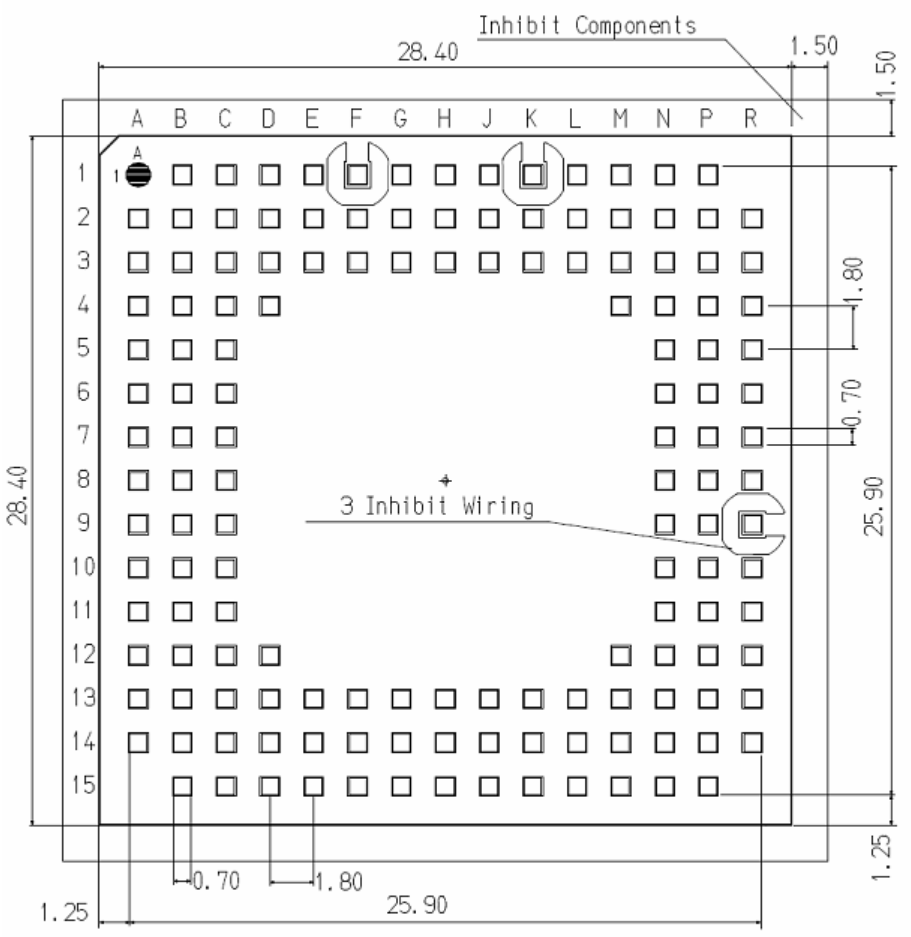

0.8±0.1
0.8±0.1
28.2±0.15
28.2±0.15


DETAIL A
SCALE 8:1
2.2 ±10%

14.3 Recommended foot print for the application



TOP VIEW

In order to easily rework the LE910 is suggested to consider on the application a 1.5 mm placement inhibit area around the module.
It is also suggested, as common rule for an SMT component, to avoid having a mechanical part of the application in direct contact with the module.

NOTE:

In the customer application, the region under WIRING INHIBIT (see figure above) must be clear from signal or ground paths.

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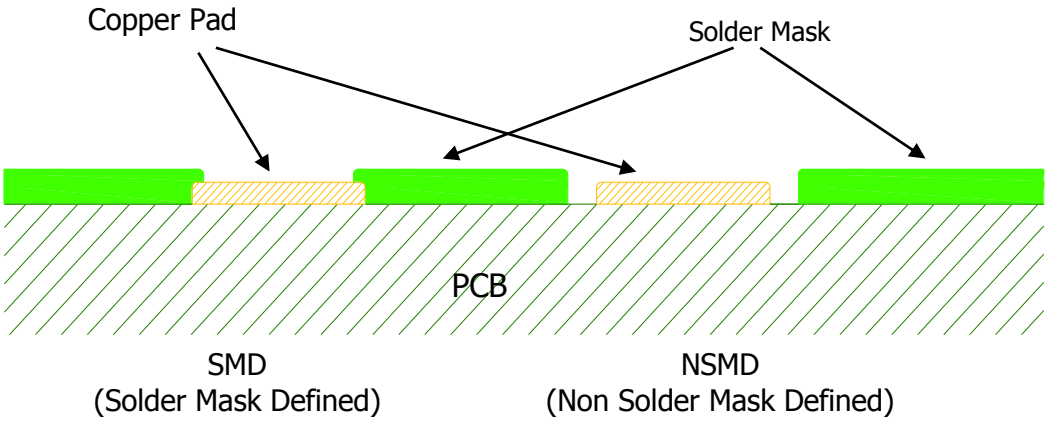
14.4 Stencil

Stencil's apertures layout can be the same of the recommended footprint (1:1), we suggest a thickness of stencil foil ≥ 120 µm.

14.5 PCB pad design

Non solder mask defined (NSMD) type is recommended for the solder pads on the PCB.



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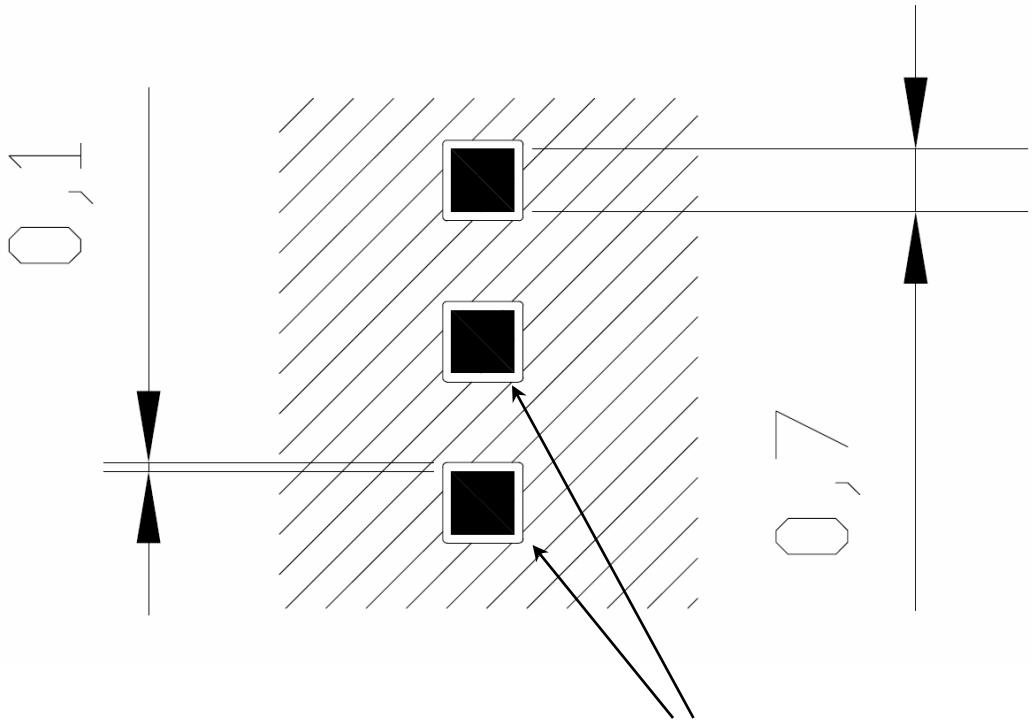
14.6 PCB pad dimensions

The recommendation for the PCB pads dimensions are described in the following image (dimensions in mm)



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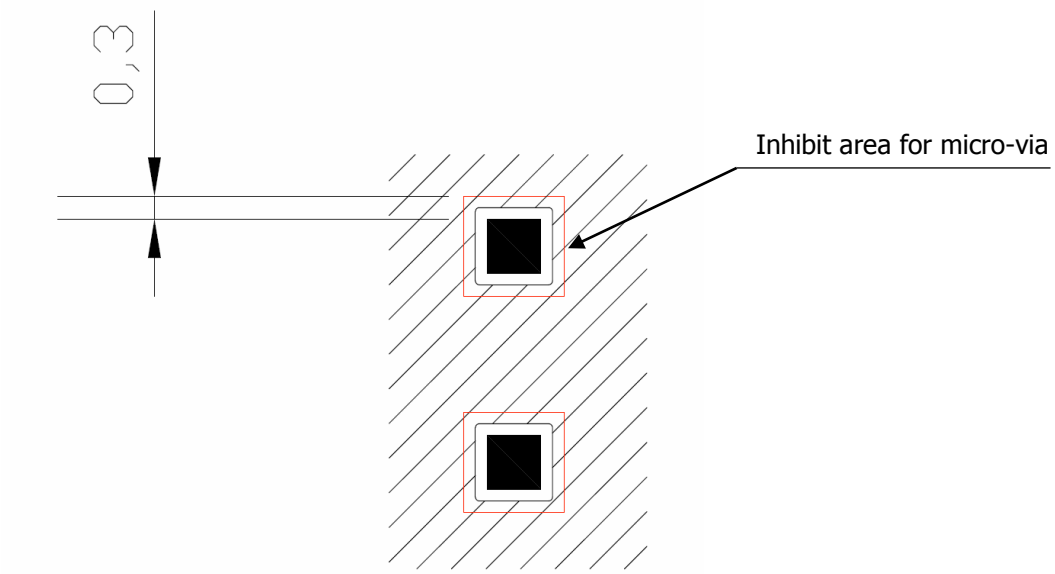
It is not recommended to place via or micro-via not covered by solder resist in an area of 0,3 mm around the pads unless it carries the same signal of the pad itself (see following figure).



Holes in pad are allowed only for blind holes and not for through holes.

Recommendations for PCB pad surfaces:

Finish	Layer thickness [µm]	Properties
Electro-less Ni / Immersion Au	3 –7 / 0.05 – 0.15	good solder ability protection, high shear force values

The PCB must be able to resist the higher temperatures which are occurring at the lead-free process. This issue should be discussed with the PCB-supplier. Generally, the wettability of tin-lead solder paste on the described surface plating is better compared to lead-free solder paste.
It is not necessary to panel the application's PCB, however in that case it is suggested to use milled contours and predrilled board breakouts; scoring or v-cut solutions are not recommended.

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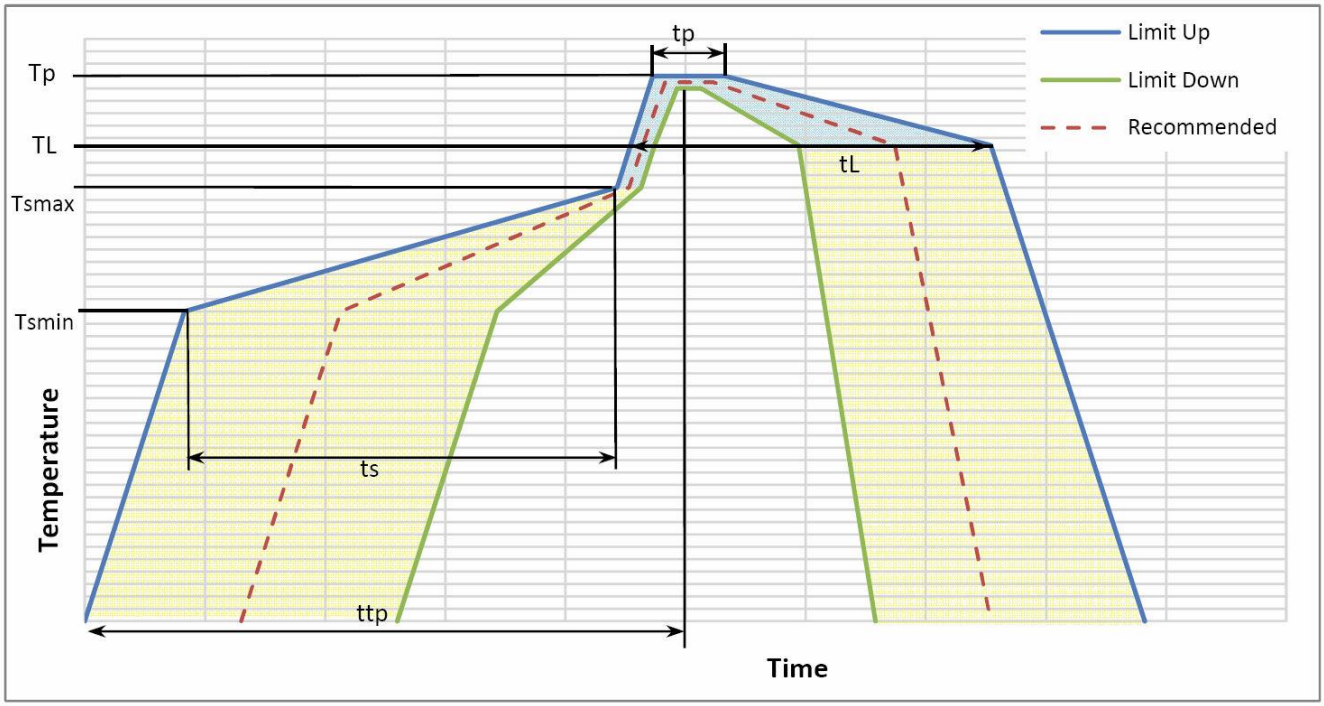
14.7 Solder paste

	Lead free
Solder paste	Sn/Ag/Cu

We recommend using only “no clean” solder paste in order to avoid the cleaning of the modules after assembly.

14.7.1 LE910 Solder reflow

Recommended solder reflow profile:



Profile Feature	Pb-Free Assembly
Average ramp-up rate (T_L to T_P)	3°C/second max
Preheat – Temperature Min (Tsmin) – Temperature Max (Tsmax) – Time (min to max) (ts)	 150°C 200°C 60-180 seconds
Tsmax to TL – Ramp-up Rate	 3°C/second max
Time maintained above: – Temperature (TL) – Time (tL)	 217°C 60-150 seconds
Peak Temperature (Tp)	245 +0/-5°C
Time within 5°C of actual Peak Temperature (tp)	10-30 seconds
Ramp-down Rate	6°C/second max.
Time 25°C to Peak Temperature	8 minutes max.

NOTE:

All temperatures refer to topside of the package, measured on the package body surface

WARNING:

The LE910 module withstands one reflow process only.

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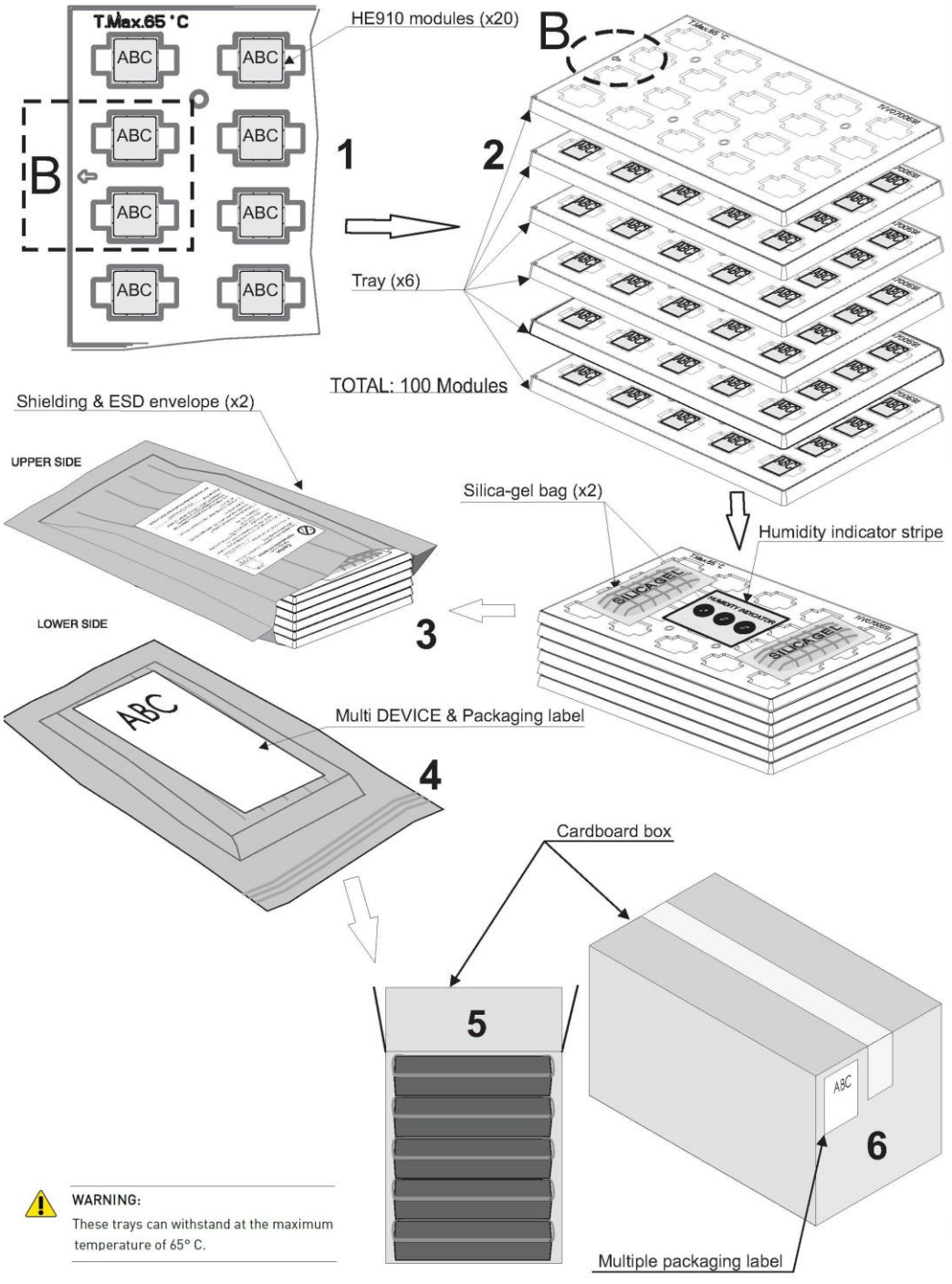
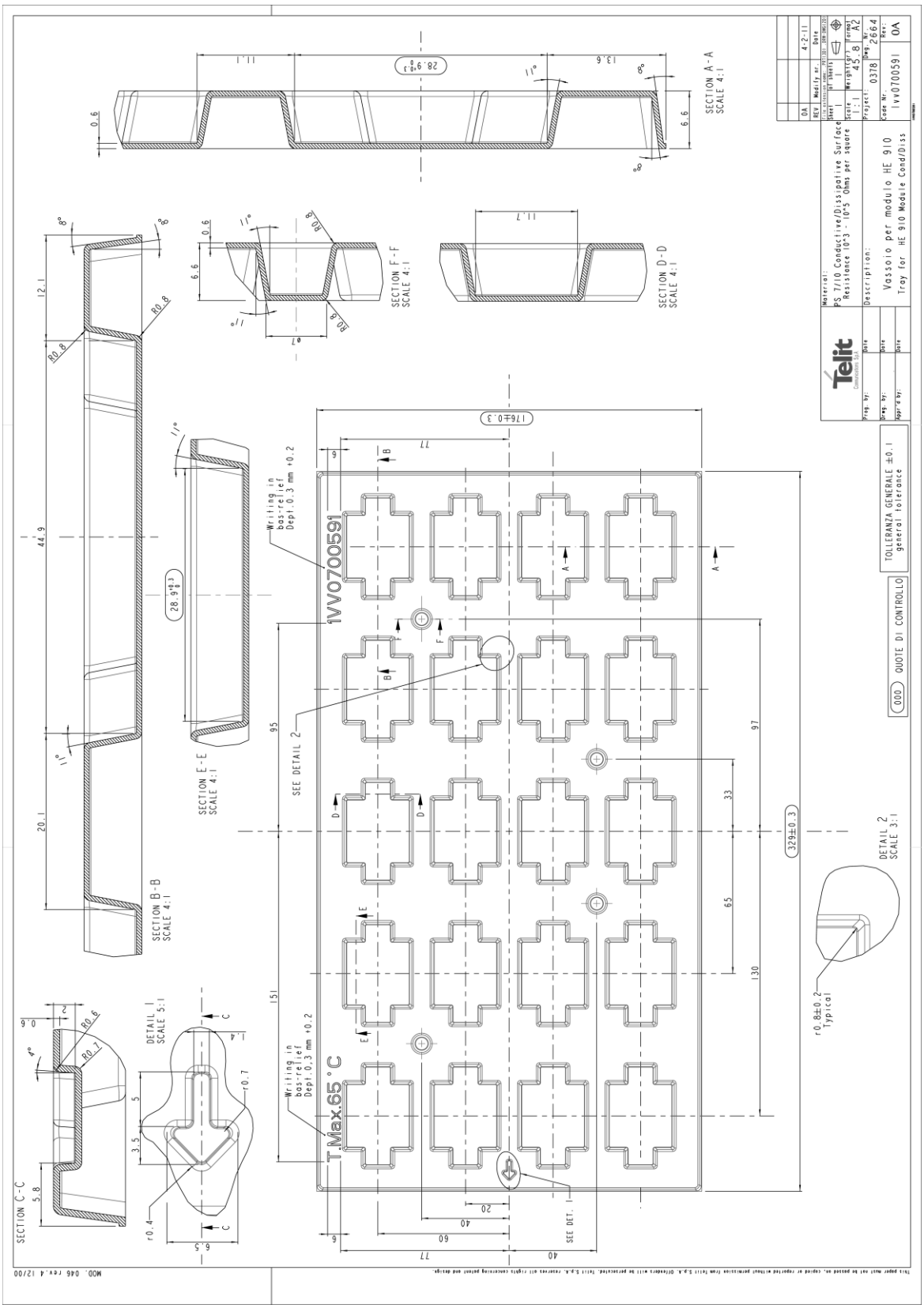
14.8 Packing system (Tray)

The LE910 modules are packaged on trays of ***20*** pieces each. These trays can be used in SMT processes for pick & place handling.





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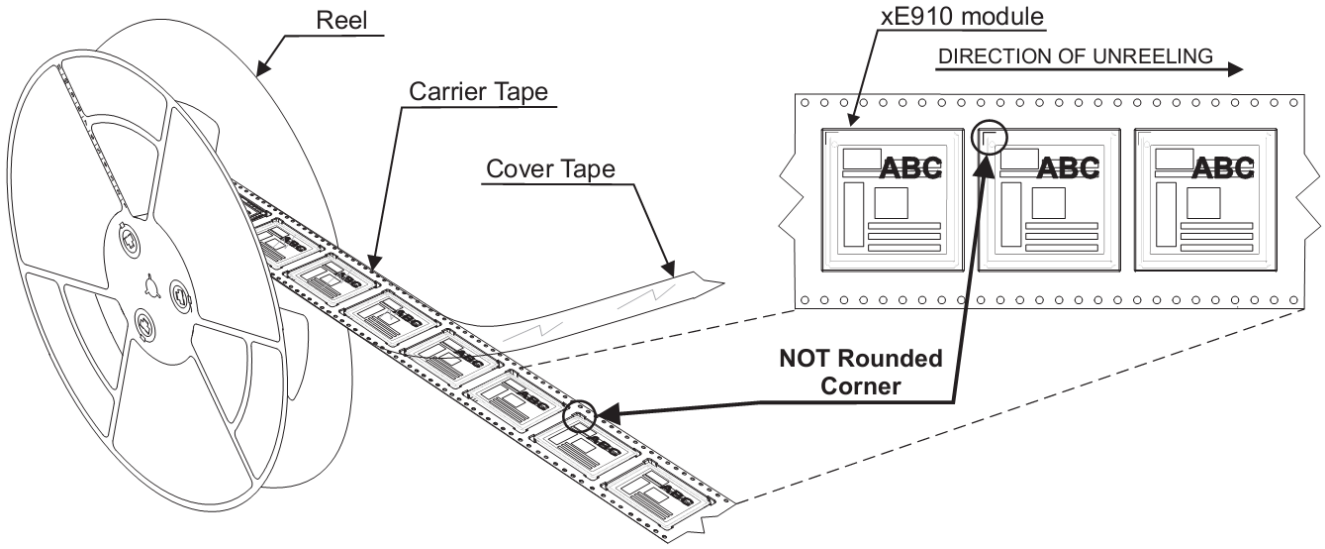
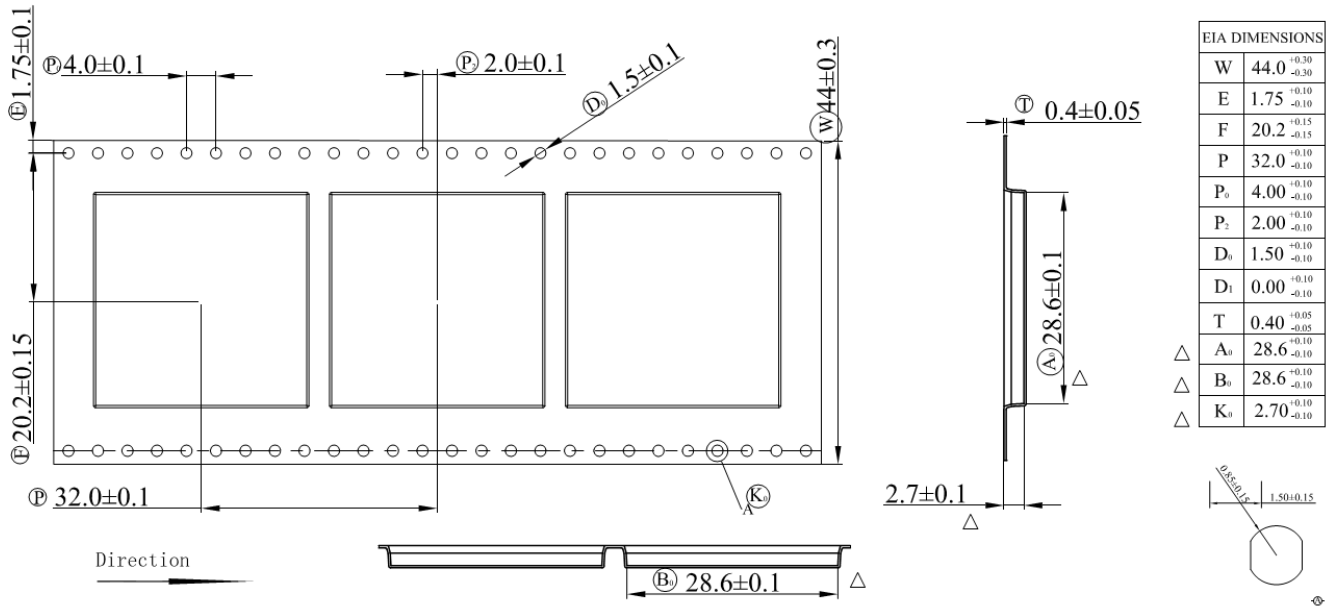
14.9 Packing System (Reel)

The LE910 can be packaged on reels of 200 pieces each.
See figure for module positioning into the carrier.



14.9.1 Carrier Tape Detail



EIA DIMENSIONS	
W	44.0 +0.30 -0.30
E	1.75 +0.10 -0.10
F	20.2 +0.15 -0.15
P	32.0 +0.10 -0.10
P_0	4.00 +0.10 -0.10
P_2	2.00 +0.10 -0.10
D_0	1.50 +0.10 -0.10
D_1	0.00 +0.10 -0.10
T	0.40 +0.05 -0.05
A_0	28.6 +0.10 -0.10
B_0	28.6 +0.10 -0.10
K_0	2.70 +0.10 -0.10

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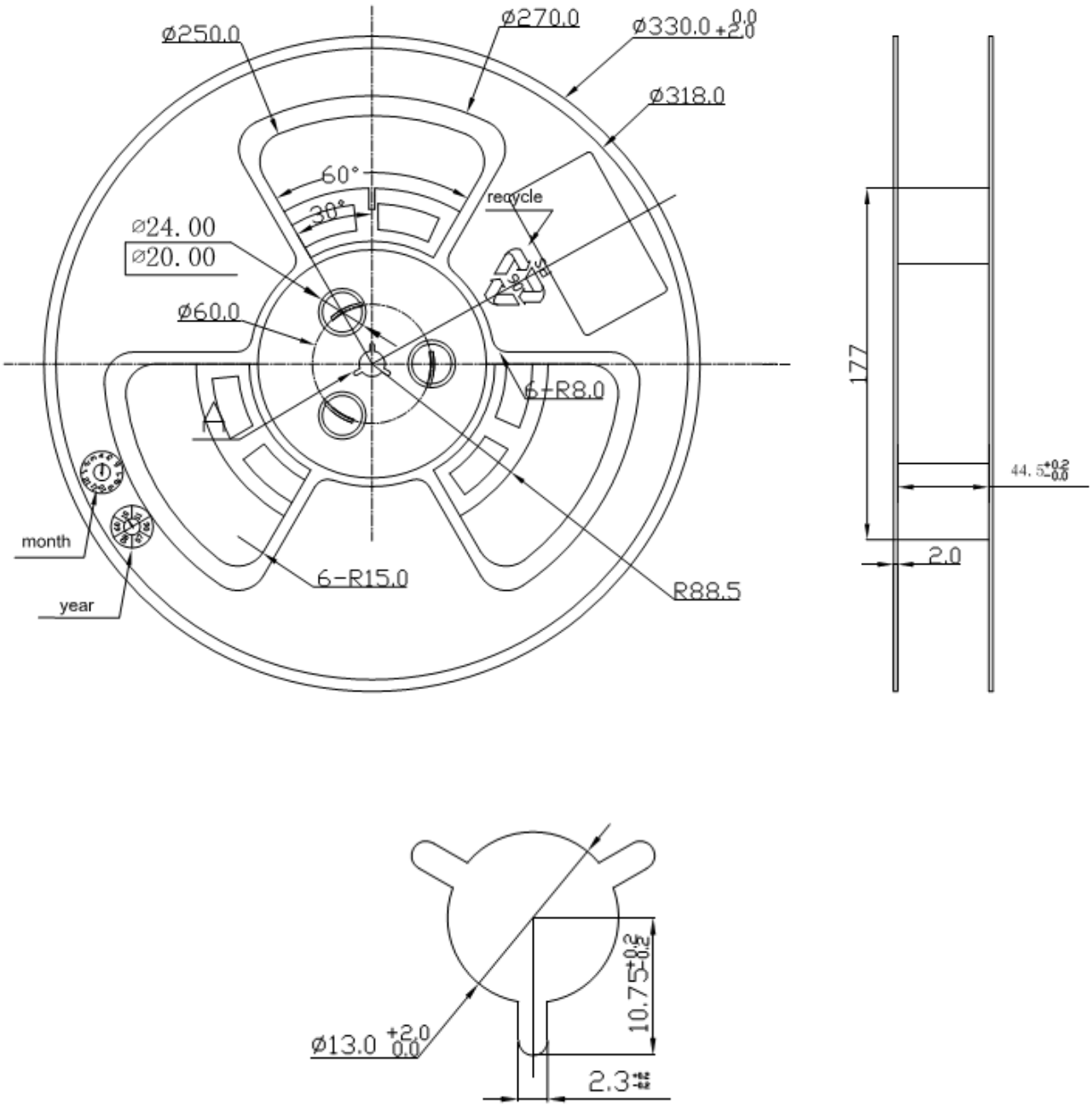
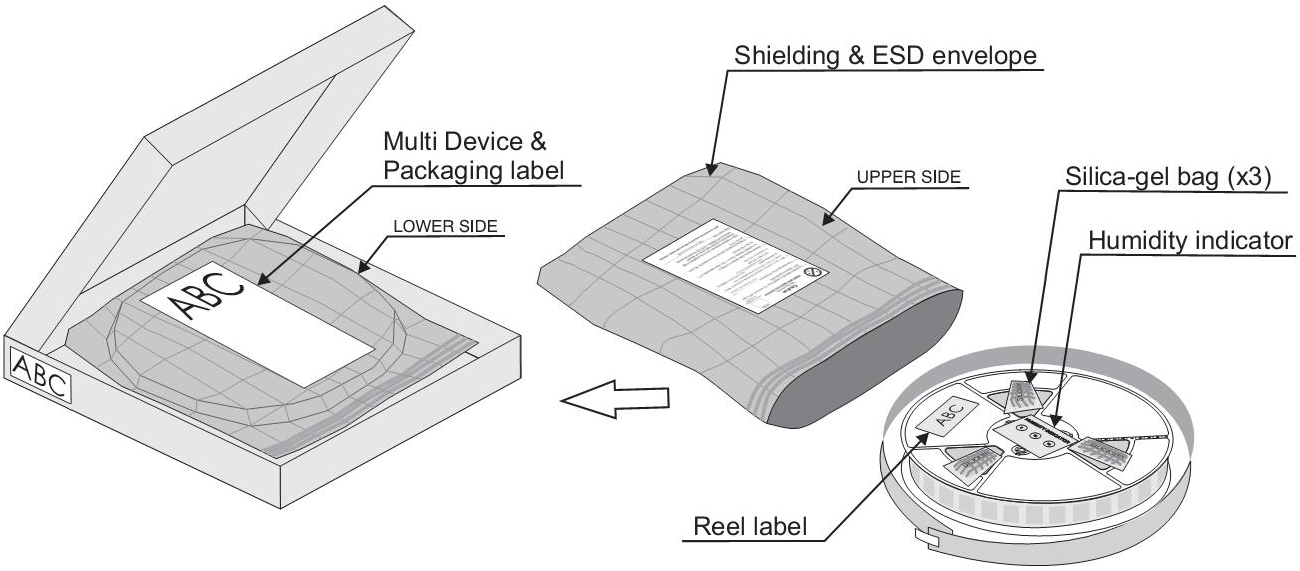
14.9.2 Reel Detail



14.9.3 Packaging Detail



14.10 Moisture sensitivity

The LE910 is a Moisture Sensitive Device level 3, in according with standard IPC/JEDEC J-STD-020, take care all the relatives requirements for using this kind of components.
Moreover, the customer has to take care of the following conditions:
a) Calculated shelf life in sealed bag: 12 months at <40°C and <90% relative humidity (RH).
b) Environmental condition during the production: 30°C / 60% RH according to IPC/JEDEC J-STD-033A paragraph 5.
c) The maximum time between the opening of the sealed bag and the reflow process must be 168 hours if condition b) "IPC/JEDEC J-STD-033A paragraph 5.2" is respected
d) Baking is required if conditions b) or c) are not respected
e) Baking is required if the humidity indicator inside the bag indicates 10% RH or more

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15 SAFETY RECOMMANDATIONS

READ CAREFULLY

Be sure the use of this product is allowed in the country and in the environment required. The use of this product may be dangerous and has to be avoided in the following areas:

- Where it can interfere with other electronic devices in environments such as hospitals, airports, aircrafts, etc
- Where there is risk of explosion such as gasoline stations, oil refineries, etc

It is responsibility of the user to enforce the country regulation and the specific environment regulation.

Do not disassemble the product; any mark of tampering will compromise the warranty validity.

We recommend following the instructions of the hardware user guides for a correct wiring of the product. The product has to be supplied with a stabilized voltage source and the wiring has to be conforming to the security and fire prevention regulations.

The product has to be handled with care, avoiding any contact with the pins because electrostatic discharges may damage the product itself. Same cautions have to be taken for the SIM, checking carefully the instruction for its use. Do not insert or remove the SIM when the product is in power saving mode.

The system integrator is responsible of the functioning of the final product; therefore, care has to be taken to the external components of the module, as well as of any project or installation issue, because the risk of disturbing the GSM network or external devices or having impact on the security. Should there be any doubt, please refer to the technical documentation and the regulations in force.

Every module has to be equipped with a proper antenna with specific characteristics. The antenna has to be installed with care in order to avoid any interference with other electronic devices and has to guarantee a minimum distance from the body (20 cm). In case of this requirement cannot be satisfied, the system integrator has to assess the final product against the SAR regulation.

The European Community provides some Directives for the electronic equipments introduced on the market. All the relevant information's are available on the European Community website:

http://europa.eu.int/comm/enterprise/rtte/dir99-5.htm

The text of the Directive 99/05 regarding telecommunication equipments is available, while the applicable Directives (Low Voltage and EMC) are available at:

http://europa.eu.int/comm/enterprise/electr_equipment/index_en.htm

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16 Conformity assessment issues

16.1 1999/5/EC Directive

The LE910-EUG module has been evaluated against the essential requirements of the 1999/5/EC Directive.

Bulgarian	С настоящето Telit Communications S.p.A. декларира, че 2G/3G/LTE module отговаря на съществените изисквания и другите приложими изисквания на Директива 1999/5/ЕС.
Czech	Telit Communications S.p.A. tímto prohlašuje, že tento 2G/3G/LTE module je ve shodě se základními požadavky a dalšími příslušnými ustanoveními směrnice 1999/5/ES.
Danish	Undertegnede Telit Communications S.p.A. erklærer herved, at følgende udstyr 2G/3G/LTE module overholder de væsentlige krav og øvrige relevante krav i direktiv 1999/5/EF.
Dutch	Hierbij verklaart Telit Communications S.p.A. dat het toestel 2G/3G/LTE module in overeenstemming is met de essentiële eisen en de andere relevante bepalingen van richtlijn 1999/5/EG.
English	Hereby, Telit Communications S.p.A., declares that this 2G/3G/LTE module is in compliance with the essential requirements and other relevant provisions of Directive 1999/5/EC.
Estonian	Käesolevaga kinnitab Telit Communications S.p.A. seadme 2G/3G/LTE module vastavust direktiivi 1999/5/EÜ põhinõuetele ja nimetatud direktiivist tulenevatele teistele asjakohastele sätetele.
German	Hiermit erklärt Telit Communications S.p.A., dass sich das Gerät 2G/3G/LTE module in Übereinstimmung mit den grundlegenden Anforderungen und den übrigen einschlägigen Bestimmungen der Richtlinie 1999/5/EG befindet.
Greek	ΜΕ ΤΗΝ ΠΑΡΟΥΣΑ Telit Communications S.p.A. ΔΗΛΩΝΕΙ ΟΤΙ 2G/3G/LTE module ΣΥΜΜΟΡΦΩΝΕΤΑΙ ΠΡΟΣ ΤΙΣ ΟΥΣΙΩΔΕΙΣ ΑΠΑΙΤΗΣΕΙΣ ΚΑΙ ΤΙΣ ΛΟΙΠΕΣ ΣΧΕΤΙΚΕΣ ΔΙΑΤΑΞΕΙΣ ΤΗΣ ΟΔΗΓΙΑΣ 1999/5/ΕΚ.
Hungarian	Alulírott, Telit Communications S.p.A. nyilatkozom, hogy a 2G/3G/LTE module megfelel a vonatkozó alapvetõ követelményeknek és az 1999/5/EC irányelv egyéb elõírásainak.
Finnish	Telit Communications S.p.A. vakuuttaa täten että 2G/3G/LTE module tyyppinen laite on direktiivin 1999/5/EY oleellisten vaatimusten ja sitä koskevien direktiivin muiden ehtojen mukainen.
French	Par la présente Telit Communications S.p.A. déclare que l'appareil 2G/3G/LTE module est conforme aux exigences essentielles et aux autres dispositions pertinentes de la directive 1999/5/CE.
Icelandic	Hér með lýsir Telit Communications S.p.A. yfir því að 2G/3G/LTE module er í samræmi við grunnkröfur og aðrar kröfur, sem gerðar eru í tilskipun 1999/5/EC

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Italian	Con la presente Telit Communications S.p.A. dichiara che questo 2G/3G/LTE module è conforme ai requisiti essenziali ed alle altre disposizioni pertinenti stabilite dalla direttiva 1999/5/CE.
Latvian	Ar šo Telit Communications S.p.A. deklarē, ka 2G/3G/LTE module atbilst Direktīvas 1999/5/EK būtiskajām prasībām un citiem ar to saistītajiem noteikumiem.
Lithuanian	Šiuo Telit Communications S.p.A. deklaruoja, kad šis 2G/3G/LTE module atitinka esminius reikalavimus ir kitas 1999/5/EB Direktyvos nuostatas.
Maltese	Hawnhekk, Telit Communications S.p.A., jiddikjara li dan 2G/3G/LTE module jikkonforma mal-ħtiġijiet essenzjali u ma provvedimenti oħrajn relevanti li hemm fid-Dirrettiva 1999/5/EC.
Norwegian	Telit Communications S.p.A. erklærer herved at utstyret 2G/3G/LTE module er i samsvar med de grunnleggende krav og øvrige relevante krav i direktiv 1999/5/EF.
Polish	Niniejszym Telit Communications S.p.A. oświadcza, że 2G/3G/LTE module jest zgodny z zasadniczymi wymogami oraz pozostałymi stosownymi postanowieniami Dyrektywy 1999/5/EC
Portuguese	Telit Communications S.p.A. declara que este 2G/3G/LTE module está conforme com os requisitos essenciais e outras disposições da Directiva 1999/5/CE.
Slovak	Telit Communications S.p.A. týmto vyhlasuje, že 2G/3G/LTE module spĺňa základné požiadavky a všetky príslušné ustanovenia Smernice 1999/5/ES.
Slovenian	Telit Communications S.p.A. izjavlja, da je ta 2G/3G/LTE module v skladu z bistvenimi zahtevami in ostalimi relevantnimi določili direktive 1999/5/ES.
Spanish	Por medio de la presente Telit Communications S.p.A. declara que el 2G/3G/LTE module cumple con los requisitos esenciales y cualesquiera otras disposiciones aplicables o exigibles de la Directiva 1999/5/CE.
Swedish	Härmed intygar Telit Communications S.p.A. att denna 2G/3G/LTE module står I överensstämmelse med de väsentliga egenskapskrav och övriga relevanta bestämmelser som framgår av direktiv 1999/5/EG.

In order to satisfy the essential requirements of 1999/5/EC Directive, the LE910-EUG module is compliant with the following standards:

RF spectrum use (R&TTE art. 3.2)	EN 300 440-2 V1.4.1 EN 301 511 V9.0.2 EN 301 908-1 V6.2.1 EN 301 908-2 V5.4.1 EN 301 908-13 V5.2.1
EMC (R&TTE art. 3.1b)	EN 301 489-1 V1.9.2 EN 301 489-3 V1.6.1 EN 301 489-7 V1.3.1 EN 301 489-24 V1.5.1
Health & Safety (R&TTE art. 3.1a)	EN 60950-1:2006 + A11:2009 + A1:2010 + A12:2011 + AC:2011 EN 62311:2008 EN 62479:2010

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The conformity assessment procedure referred to in Article 10 and detailed in Annex IV of Directive 1999/5/EC has been followed with the involvement of the following Notified Body:

AT4 wireless, S.A.
Parque Tecnologico de Andalucía
C/ Severo Ochoa 2
29590 Campanillas – Málaga
SPAIN
Notified Body No: 1909

Thus, the following marking is included in the product:

CE 1909

The full declaration of conformity can be found on the following address:
http://www.telit.com/

There is no restriction for the commercialisation of the LE910-EUG modules in all the countries of the European Union.

Final product integrating this module must be assessed against essential requirements of the 1999/5/EC (R&TTE) Directive. It should be noted that assessment does not necessarily lead to testing. Telit Communications S.p.A. recommends carrying out the following assessments:

RF spectrum use (R&TTE art. 3.2)	It will depend on the antenna used on the final product.
EMC (R&TTE art. 3.1b)	Testing
Health & Safety (R&TTE art. 3.1a)	Testing

Alternately, assessment of the final product against EMC (Art. 3.1b) and Electrical safety (Art. 3.1a) essential requirements can be done against the essential requirements of the EMC and the LVD Directives:

- Low Voltage Directive 2006/95/EC and product safety
- Directive EMC 2004/108/EC for conformity for EMC

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16.2 FCC/IC Regulatory notices

Modification statement

Telit has not approved any changes or modifications to this device by the user. Any changes or modifications could void the user's authority to operate the equipment.

Telit n'approuve aucune modification apportée à l'appareil par l'utilisateur, quelle qu'en soit la nature. Tout changement ou modification peuvent annuler le droit d'utilisation de l'appareil par l'utilisateur.

Interference statement

This device complies with Part 15 of the FCC Rules and Industry Canada licence-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes : (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Wireless notice

This equipment complies with FCC and IC radiation exposure limits set forth for an uncontrolled environment. The antenna should be installed and operated with minimum distance of 20 cm between the radiator and your body. Antenna gain must be below:

Frequency band	LE910-NAG	LE910-NVG	LE910-SVG
700 MHz	8.74 dBi	9.16 dBi	6.93 dBi
850 MHz	6.93 dBi	9.42 dBi	N/A
1700 MHz	5.00 dBi	5.00 dBi	5.00 dBi
1900 MHz	2.51 dBi	8.01 dBi	N/A

This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

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Cet appareil est conforme aux limites d'exposition aux rayonnements de la IC pour un environnement non contrôlé. L'antenne doit être installé de façon à garder une distance minimale de 20 centimètres entre la source de rayonnements et votre corps. Gain de l'antenne doit être ci-dessous:

Bande de fréquence	**LE910-NAG**	**LE910-NVG**	**LE910-SVG**
700 MHz	8.74 dBi	9.16 dBi	6.93 dBi
850 MHz	6.93 dBi	9.42 dBi	N/A
1700 MHz	5.00 dBi	5.00 dBi	5.00 dBi
1900 MHz	2.51 dBi	8.01 dBi	N/A

L'émetteur ne doit pas être colocalisé ni fonctionner conjointement avec à autre antenne ou autre émetteur.

FCC Class B digital device notice

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

Labelling Requirements for the Host device

The host device shall be properly labelled to identify the modules within the host device. The certification label of the module shall be clearly visible at all times when installed in the host device, otherwise the host device must be labelled to display the FCC ID and IC of the module, preceded by the words "Contains transmitter module", or the word "Contains", or similar wording expressing the same meaning, as follows:

LE910-NAG

Contains FCC ID: RI7LE910NA
Contains IC: 5131A-LE910NA

LE910-NVG

Contains FCC ID: RI7LE910NV
Contains IC: 5131A-LE910NV

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LE910-SVG

Contains FCC ID: RI7LE910SV
Contains IC: 5131A-LE910SV

L'appareil hôte doit être étiqueté comme il faut pour permettre l'identification des modules qui s'y trouvent. L'étiquette de certification du module donné doit être posée sur l'appareil hôte à un endroit bien en vue en tout temps. En l'absence d'étiquette, l'appareil hôte doit porter une étiquette donnant le FCC ID et le IC du module, précédé des mots « Contient un module d'émission », du mot « Contient » ou d'une formulation similaire exprimant le même sens, comme suit :

LE910-NAG

Contains FCC ID: RI7LE910NA
Contains IC: 5131A-LE910NA

LE910-NVG

Contains FCC ID: RI7LE910NV
Contains IC: 5131A-LE910NV

LE910-SVG

Contains FCC ID: RI7LE910SV
Contains IC: 5131A-LE910SV

CAN ICES-3 (B) / NMB-3 (B)

This Class B digital apparatus complies with Canadian ICES-003.

Cet appareil numérique de classe B est conforme à la norme canadienne ICES-003.

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